

Special Report 80-3

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STATISTICAL PACKAGE USER'S GUIDE

Julie A. Hopson and George A. Cotsonis



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August 1980

NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
PENSACOLA, FLORIDA

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ERRATA SHEET for NAMRL Special Report 80-3

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The following corrections should be made to subject report.

<u>Page No.</u>	<u>Line No.</u>	<u>Correction</u>
iii	11.B.4.	ANOVA, One Repeated Measure vice ANOVA, Repeated Measures
iii	11.C.2.	One-way ANOVA vice Two-way ANOVA
iv	11.D.6.	Rotation vice Location
34	22	Add as last sentence to Test Data: The same data used in SRM30 (See SRM30) was used for testing program.
41	12	$X_{ij} = u$ vice $X_{ij} = i$
61	1	One Repeated Measure vice Repeated Measures
77	12	$B_j + C_k$ vice $B_j - C_k$
110	24	Add the following columns to the bottom of page:
		RAW DATA 3.000 4.000 7.000 7.000 6.000 5.000 8.000 8.000 3.000 4.000 7.000 9.000 3.000 3.000 6.000 8.000 1.000 2.000 5.000 10.000 2.000 3.000 6.000 10.000 2.000 4.000 5.000 9.000 2.000 3.000 6.000 11.000
144	13/15	$(X_{ijm} - \bar{X}_{ij.}) = u + A_i + B_j + AB_{ij} + \tau_{m(i)} + B\tau_{jm(i)} + E_{ijm}$ vice $(X_{ijm} - \bar{X}_{...}) = u + A_i - B_j + AB_{ij} + \tau_{m(i)} +$ $B\tau_{jm(i)} + E_{ijm}$
164	1	One-way ANOVA vice Two-way ANOVA
174	12	$= u_{(r)}$ vice $= M_{(r)}$
247	1	(Varimax Rotation) vice (Varimax Location)

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Julie A. Hopson and George A. Cotsonis

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SUMMARY

The Statistical Package User's Guide represents an aggregation of a variety of statistical analysis. The types of statistical programs available are: Analysis of Variance, Analysis of Covariance, Multivariate Analysis of Variance, Regression Analysis, Factor Analysis, Descriptive Statistics, and Nonparametric Statistics. The User's Guide provides the following documentation for each program: General Description, Mathematical Model, Operational Procedures, Test Data Statistical Analysis, and Software Coding.

ACKNOWLEDGEMENTS

The Statistical Package is the culmination of the efforts of many persons in developing, converting and implementing the programs involved. The authors wish to acknowledge all those who have contributed to this project. Special thanks are due to Peter Collyer for his programming efforts, Del Turner for his typing of the manuscript, and Dr. J. E. Goodson for supporting the project. The authors wish to thank Mr. John Bowman for his guidance and assistance in our understanding and utilization of the available hardware and systems capabilities, and for his diagnostic and corrective actions during test and evaluation of several of the programs. Particular acknowledgement is due Rachel Gadolin for her efforts in the delivery of the final product.

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TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	1
I. Utility Programs	4
A. DA30 Data File Creation	5
B. STORT Data File Storage/Retrieval	10
C. EDIT Data File Editor	14
D. TRAFAM Data Transformation	18
II. Parametric Statistics	31
A. Descriptive Statistics	32
1. DSPD Parametric Descriptive Statistics	33
B. Analysis of Variance and Covariance	40
1. AV10 One-way ANOVA	41
2. AV11 One-way ANOVA, Repeated Measures	47
3. AV20 Two-way ANOVA	53
4. AV21B Two-way Split Plot ANOVA, Repeated Measures	61
5. AV22 Two-way ANOVA, Repeated Measures	69
6. AV30 Three-way ANOVA	77
7. AV31C Three-way Split Plot ANOVA, One Repeated Measure	88
8. AV32BC Three-way Split Plot ANOVA, Two Repeated Measures	97
9. AV33 Three-way ANOVA, Repeated Measures	107
10. AC10 One-way Analysis of Covariance	116
11. AC11 One-way Analysis of Covariance, Repeated Measures	125
12. AC20 Two-way Analysis of Covariance	134
13. AC21B Two-way Split Plot Analysis of Covariance, One	144
Repeated Measure	
C. Multivariate Analysis of Variance	155
1. MAV10 Multivariate One-way ANOVA	156
2. MAV11 Multivariate Two-way ANOVA, Repeated Measures	164
3. MAV20 Multivariate Two-way ANOVA	174

	<u>Page</u>
D. Regression and Factor Analysis	184
1. SREGR Simple Linear Regression	185
2. SRM30 Correlation Matrix	191
3. MRMAIN Multiple Regression Analysis	200
4. RESID Residual Plot	217
5. FATAA Factor Analysis	226
6. VARI Varimax Location	247
III. Nonparametric Statistics	254
A. RANK Column Ranking	255
B. ORANK Matrix Ranking	261
C. STACH Nonparametric Descriptive Statistics	265
D. CHIRA Coefficient of Concordance	274
E. CHISQ Chi-square	286
APPENDIX A Generalized Subroutines	292

INTRODUCTION

The Statistical Package User's Guide represents an attempt to aggregate a variety of statistical programs in the Aerospace Psychology Department at the Naval Aerospace Medical Research Laboratory (NAMRL) into one standard package. Some of the statistical programs included in the statistical package were developed at the Naval Aerospace Medical Research Laboratory for the UNIVAC 418 and NOVA 800; others were programs obtained from different universities with multifarious computer capability and programming languages. Selection of programs in the statistical package was based upon investigator needs and computer core requirements. The intention was to provide a diversity of basic statistical programs for experimental investigators which matched research requirements and which could be readily utilized in the majority of the Naval Aerospace Medical Research Laboratory computer facilities.

For standardization, all statistical programs were coded in Fortran IV language and sized to fit a mini-computer with 32k memory. The programs were originally converted to a Hewlett Packard (HP) 2100 mini-computer but were structured so that only minor changes in the input/output (I/O) requirements (i.e., device codes and disk file formats) would be necessary for the statistical package to be compatible with another system. Programs were also structured so that they could be used by investigators with limited computer skills. It was intended that the organizational/structural philosophy of the statistical package serve as a guideline for new programs. If the same general philosophy is adhered to when developing other statistical analyses, new programs could be readily shared by multiple users, thereby expanding the statistical package with minimal programming efforts and costs.

Once the programs were converted to the HP mini-computer, each was checked carefully for accuracy. Documented data were obtained from specific sources to check the calculation of the statistical analyses. An estimate of the digit accuracy was obtained by comparing the results of the HP calculation with those obtained from other computing sources. Most comparisons were made using the Statistical Analyses System and the Statistical Package for Social Sciences, two data analysis packages residing on the IBM 360 system at University of West Florida. Most of the programs were accurate to ten digit places; exceptions to this are noted in the user's guide. When comparison analyses were done with systems that had less computing power than the HP-2100, double precision was used in the calculations to insure minimal rounding-off errors. All data analyses performed on the HP-2100 have been included in the guide so that calculations can be double checked if a malfunction is suspected or to verify whether the operator is entering the data properly.

Standard operating procedures for a specific system is the only computer skill needed to use the statistical package. It will be necessary to generate a separate data file prior to calling up a specific analysis. The data files can either be created using DA30 or constructed during an experimental run. The format of the data is dependent upon the desired statistical analysis and is specified in the guide. When a data file is not organized appropriately, edit or sorting commands of the system being used is typically adequate to rearrange files in the necessary format. For other systems, it may be desirable to write a generalized utility program to change data file organization.

The notation used for the formulas in the statistical package should be familiar to the general user. Although alphanumeric letters are used in the models rather than standard greek letters, with the exception of Tau (π), the reader should have no difficulty in interpreting the equations. For a few cases, computer notation was used (i.e., transformation equations). For these, the following notation is utilized:

* = multiplication sign

$$x^{**} = x^2$$

$$x^{**}.5 = \sqrt{x}$$

The Analysis of Variance and Covariance programs were given two names; i.e., AV10 and CR-k. Since these analyses were developed from designs specified by Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, the unique nomenclature he used for specific designs was maintained in the guide for reference. When calling up any of these statistical programs, only the AV or AC notation will be accepted. For the split-plot analyses the AV notation is accompanied by alphanumeric letters to indicate which factors are the within variables. AV31C means that A and B are the between group factors and C the within factor.

I. UTILITY PROGRAMS

DA30 (Data File Creation)

Purpose:

This program creates data files for the stat-pack on the HP2100. The data are entered by hand at the computer console and permanently stored on the disc.

User Considerations and Procedures:

1. Check "User Considerations and Procedures" of the various statistical programs to see how the data should be formatted - some require data in matrix form, others in sequential form.

2. DA30 will ask for the following

- a. format for data output. This is the format per line of data required for the statistical program. Respond by giving any legal HP-FORTRAN IV format statement, enclosing the format in parentheses. For example:

- 1) (15)
- 2) (15, F7.3, F9.7, 16)
- 3) (30, (1X, F10.4))

NOTE: The word format should not be given.

- b. logical record length. This is the number of characters per line of data created. Spaces should be included. For the example above, the record lengths are:

- 1) 5
- 2) $5 + 7 + 9 + 6 = 27$
- 3) $30 * (1 + 10) = 30 * 11 = 330$

The maximum length is 512 characters per line.

- c. number of observations across. This is the number of variables per line. (Some statistical programs require one per line, others require many.) For the three examples above, this is:

- 1) 1
- 2) 4
- 3) 30

- d. number of levels down. This is the number of records to be created in the file. The maximum number of records that can be contained in a file is 32767.
- e. data file name. Enter name of the file to be created (maximum of six characters)

NOTE: Imbedded blanks are illegal. Do not use a name that is already stored on the disc.

3. Procedures for entering data via keyboard:

- a. to enter only one variable per record, enter value, then hit 'return'
- b. to enter 10 or fewer variables per record, enter the values by row, separating each with a comma. Terminate the row with a 'return'
- c. to enter more than 10 variables per record, enter data across in groups of 10 variables. Separate each variable with a comma, and terminate each 10 with a 'return'. For example, for 17 variables per line, enter first 10 values separating each by a comma, hit 'return', enter next 7 values separating each by a comma, hit 'return', then go to next record

Comments:

Keep a separate memo of the name, format, and record length for use in stat-pack programs. This is not saved on the disc file.

To purge a data file from the disc, enter: PU, 'data file name'; PK, 2.

To store a data file on tape run the STORT program. The purge option can be used to delete the data file from the disc.

RU,DA30
 DATA30
 CREATE A DATA FILE FOR INPUT TO STAT PKG.
 INPUT TO DATA FILE IS A 2-DIMENSIONAL ARRAY
 MAXIMUM OF 30 VALUES ACROSS, 32767 VALUES DOWN
 NO RECORD IS KEPT OF FILE ORGANIZATION
 ENTER OUTPUT FILE NAME - UP TO 6 CHARACTERS
 YEW
 ENTER LENGTH OF RECORD : FOR EXAMPLE
 IF YOUR FORMAT IS (15(5X,F10.4)) YOUR LENGTH WOULD BE
 $15 * (5 + 10) = 225$
 180
 ENTER DESIRED OUTPUT FORMAT
 (30(1X,F5.1))
 ENTER # OF OBSERVATIONS ACROSS
 30
 ENTER # OF LEVELS DOWN
 3
 ENTER DATA VALUES BY ROWS IN GROUPS OF 10
 VARIABLES, SEPARATE EACH DATA VALUE BY A COMMA
 TERMINATE EACH 10 WITH CARRIAGE RETURN, IE :
 IF YOU HAD 17 VARIABLES ENTER IN FIRST 10 , HIT 'RETURN'
 THEN ENTER FINAL 7 AND HIT 'RETURN'

 ROW 1
 1,2,3,4,5,6,7,8,9,10
 11,12,13,14,15,16,17,18,19,20
 21,22,23,24,25,26,27,28,29,30
 ROW 2
 10,20,30,40,50,60,70,80,90,100
 110,120,129,156,178,333,444,555,666,777
 888,999,111,222,345,456,507,678,789,890
 ROW 3
 15,25,35,45,55,65,75,85,95,105
 29,39,49,59,99,109,76,35,33,22
 11,22,33,44,55,66,77,88,99,0
 YOUR DATA FILE YEW IS NOW CREATED,
 :

"DA30 T=00003 IS ON CR00002 USING 00014 BLKS R=0000

```

0001 FTM4
0002 PROGRAM DA30
0003 DIMENSION ACROSS(100),NAMA(3),ID(272)
0004 DIMENSION IBUF(257),ISIZE(2),IFMT(20)
0005 WRITE(1,17)
0006 17 FORMAT(" DA30 ",/, " CREATES A DATA FILE FOR INPUT TO ",
0007 1"STAT PKG. ",/, " INPUT TO DATA FILE IS A 2-DIMENSIONAL"
0008 2," ARRAY",/, "MAXIMUM OF 30 VALUES ACROSS, UNLIMITED "
0009 3,"VALUES DOWN",/, "NO RECORD IS KEEP OF FILE ORGANIZATION",
0010 4/, "ENTER OUTPUT FILE NAME - UP TO 6 CHARACTERS")
0011 READ(1,18) NAMA
0012 18 FORMAT(3A2)
0013 234 FORMAT(20A2)
0014 WRITE(1,703)
0015 703 FORMAT(" ENTER LENGTH OF RECORD : FOR EXAMPLE ")
0016 756 WRITE(1,705)
0017 705 FORMAT(" IF YOUR FORMAT IS (15(5X,F10.4)) YOUR LENGTH WOULD BE",
0018 1/, " 15 * ( 5 + 10 ) = 225")
0019 READ(1,*) LENGTH
0020 LEN=LENGTH/2
0021 IF((LEN*2).NE.LENGTH) LEN=LEN+1
0022 LENGTH=LEN
0023 IF(LEN.LE.256) GO TO 256
0024 WRITE(1,706)
0025 706 FORMAT(" LENGTH IS TOO LARGE, MAX IS 512")
0026 GO TO 756
0027 256 IDCBS=256
0028 ISIZE(2)=LENGTH
0029 120 WRITE(1,5358)
0030 5358 FORMAT(" ENTER DESIRED OUTPUT FORMAT")
0031 READ(1,234) IFMT
0032 WRITE(1,30)
0033 30 FORMAT(" ENTER # OF OBSERVATIONS ACROSS")
0034 READ(1,*) NLEV
0035 WRITE(1,31)
0036 31 FORMAT(" ENTER # OF LEVELS DOWN")
0037 READ(1,*) NGRPS
0038 SIZE=LENGTH
0039 XGRPS=NGRPS
0040 SIZE=XGRPS*SIZE/128. + 1.
0041 ISIZE(1)=SIZE
0042 755 CALL CREAT(ID,IERR,NAMA,ISIZE,2,0,-2,IDCBS)
0043 IF(IERR.GT.0) GO TO 100
0044 WRITE(1,13) IERR
0045 13 FORMAT(" ERROR # ",15," AT CREATING FILE ")
0046 STOP 13
0047 100 CALL CLOSE(ID)
0048 CALL OPEN(ID,IER,NAMA)
0049 IF(IER.GE.0) GO TO 124
0050 52 WRITE(1,459) IER
0051 459 FORMAT(" FAILED TO OPEN , IER = ",15)
0052 STOP 457

```

```

0053 124 IF(NLEV.GT.10) GO TO 666
0054 WRITE(1,32)
0055 32 FORMAT(" ENTER DATA VALUES BY ROW,SEPARATED WITH ",
0056 1"COMMAS",/,," TERMINATE ROW WITH CARRIAGE RETURN")
0057 DO 41 J2=1,NGRPS
0058 DO 66 I=1,NLEV
0059 66 ACROSS(I)=0.0
0060 WRITE(1,42) J2
0061 42 FORMAT(" ROW ",I3)
0062 READ(1,*)(ACROSS(J3),J3=1,NLEV)
0063 CALL CODE
0064 WRITE(1BUF,IFMT)(ACROSS(J3),J3=1,NLEV)
0065 CALL WRITF(ID,IER,1BUF)
0066 IF(IER.GE.0) GO TO 41
0067 WRITE(1,44) IER
0068 44 FORMAT("ERROR 0 ",I3," AT FILE WRITING")
0069 CALL CLOSE(ID)
0070 STOP 44
0071 41 CONTINUE
0072 GO TO 555
0073 666 WRITE(1,777)
0074 777 FORMAT("ENTER DATA VALUES BY ROWS IN GROUPS OF 10",/
0075 $," VARIABLES, SEPERATE EACH DATA VALUE BY A COMMA",/,
0076 2"TERMINATE EACH 10 WITH CARRIAGE RETURN, IE 1 ",/,
0077 4"IF YOU HAD 17 VARIABLES ENTER IN FIRST 10 , HIT 'RETURN'",
0078 1/"THEN ENTER FINAL 7 AND HIT 'RETURN'"/ )
0079 IH=(9+NLEV)/10
0080 DO 51 J2=1,NGRPS
0081 DO 67 I=1,NLEV
0082 67 ACROSS(I)=0.
0083 WRITE(1,42) J2
0084 DO 68 I=1,IH
0085 K=10+ I
0086 L=(I-1)*10 + 1
0087 68 READ(1,*)(ACROSS(J3),J3=L,K)
0088 CALL CODE
0089 WRITE(1BUF,IFMT) (ACROSS(J3),J3=1,NLEV)
0090 CALL WRITF(ID,IER,1BUF)
0091 IF(IER.LT.0) GO TO 52
0092 51 CONTINUE
0093 555 WRITE(1,166) NANA
0094 166 FORMAT(" YOUR DATA FILE ",J2," IS NOW CREATED",/,
0095 1" THIS PROGRAM IS FINISHED ")
0096 CALL CLOSE(ID)
0097 END
0098 END$

```

STORT (Data File Storage/Retrieval)

Purpose:

This program performs either of two operations:

Storage of data files onto tape (for backup purposes and/or permanent storage)
Retrieval of data files stored on tape

User Considerations and Procedures:

1. Data files transferred to tape will keep their same format and record length as on the disc. When tape files are retrieved, the data file can be renamed and stored on the disc.
2. Option for storage or retrieval. Enter 1 for storage of data file onto tape, and 2 for retrieval of data file from tape to the disc.
3. When option for storage onto tape is used, the program will ask if the data file is to be purged (deleted from the disc). Enter 1 for deletion, and 2 for keeping data file on disc.
4. Parameters required:
 - a. name of data file
 - 1) for storing data, this is the name of the disc data file to be transferred
 - 2) for retrieving a data file, this is the name of the disc file which the data will be transferred to
 - b. tape file number
 - 1) for storing data, program asks for the next available tape file number where the data can be stored. Files are stored on tape sequentially
 - 2) to retrieve data, program asks for the number of the tape file to be returned to a disc file

RU,STORT

:SV,4

THIS PROGRAM STORES AND RETRIEVES DATA FILES CREATED
BY DA30 AND TRAFM PROGRAMS ONTO TAPE FILES TO BE USED LATER. NOW, MOUNT
DATA TAPE AND ENTER 1 WHEN THROUGH

1

ENTER NAME OF DATA FILE

#FATAA

ENTER 1 FOR STORAGE ONTO TAPE, OR 2 FOR RETREIVAL

1

ENTER NEXT AVAILABLE FILE # ON TAPE

2

STORT FINISHED WHEN TAPE STOPS

ENTER 1 TO PURGE DATA FILE FROM DISC ELSE ENTER 0

0

:

*STORT T=00003 IS ON CR00002 USING 00010 BLKS R=0000

```

0001 FTH4
0002 PROGRAM STOR
0003 DIMENSION IFMGR(3), INAME(3), IBUF1(6), IBUF2(6)
0004 DIMENSION IB(144), IBUF(144), NAME(3)
0005 DIMENSION IBUF3(6), ID(3)
0006 DATA IBUF3/2H:P,2HU,/
0007 DATA ID/2H:P,2HK,,2H02/
0008 DATA NAME/2HST,2HOT,2HR /
0009 DATA IBUF1/2H:S,2HT,,2H0./
0010 DATA IBUF2/2H:S,2HT,/
0011 DATA IC/2H:0/
0012 J1=13100
0013 CALL OPEN(IB,IER,NAME)
0014 WRITE(1,99)
0015 REWIND 0
0016 99 FORMAT("THIS PROGRAM STORES AND RETRIEVES DATA FILES CREATED ",
0017 $/," BY DA30 AND ",
0018 $"TRAFF PROGRAMS ONTO TAPE FILES TO BE USED LATER. NOW, MOUNT",
0019 $/," DATA TAPE AND ENTER 1 WHEN THROUGH")
0020 READ(1,*) ITP
0021 60 IBUF2(6)=IC
0022 WRITE(1,1)
0023 1 FORMAT("ENTER NAME OF DATA FILE")
0024 READ(1,2) INAME
0025 2 FORMAT(3A2)
0026 WRITE(1,3)
0027 3 FORMAT("ENTER 1 FOR STORAGE ONTO TAPE, OR 2 FOR RETREIVAL")
0028 READ(1,*) IST
0029 IF(IST.EQ.1) GO TO 100
0030 WRITE(1,6)
0031 6 FORMAT("ENTER THE # OF THE FILE ON THE TAPE")
0032 READ(1,*) ITP
0033 IF(ITP.LE.1) GO TO 1040
0034 K=ITP-1
0035 1040 DO 10 I=1,3
0036 10 IBUF1(I+3)=INAME(I)
0037 CALL CODE
0038 WRITE(IBUF,23) IBUF1
0039 GO TO 20
0040 100 WRITE(1,50)
0041 50 FORMAT("ENTER NEXT AVAILABLE FILE # ON TAPE")
0042 READ(1,*) ITP
0043 IF(ITP.LE.1) GO TO 105
0044 K=ITP-1
0045 105 DO 21 I=1,3
0046 21 IBUF2(I+2)=INAME(I)
0047 CALL CODE
0048 WRITE(IBUF,23) IBUF2
0049 20 CONTINUE
0050 23 FORMAT(6A2)
0051 CALL WRITE(IB,IER,IBUF,6)
0052 WRITE(1,24)
0053 24 FORMAT("STORT FINISHED WHEN TAPE STOPS")

```

```

0054      IF(K.EQ.0) GO TO 34
0055      DO 104 J=1,K
0056 104    CALL EXEC(3,J1)
0057 34    CALL EXEC(13,100,I1,I2,I3)
0058      IF(I1.LT.0) GO TO 34
0059      IF(IST.EQ.2) GO TO 70
0060      WRITE(1,51)
0061 51    FORMAT("ENTER 1 TO PURGE DATA FILE FROM DICS",
0062      $" ELSE ENTER 0")
0063      READ(1,*) ITEST
0064      IF(ITEST.NE.1) GO TO 70
0065      DO 52 J1=1,3
0066 52    IBUF3(J1+2)=IHANE(J1)
0067      CALL CODE
0068      WRITE(IBUF,53) IBUF3
0069 53    FORMAT(5A2)
0070      CALL WRITF(10,IER,IBUF,5)
0071      CALL CODE
0072      WRITE(IBUF,54) ID
0073 54    FORMAT(3A2)
0074      CALL WRITF(10,IER,IBUF,3)
0075 70    CALL CLOSE(19)
0076      END
0077      END$

```

EDIT (Data File Editor)

Purpose:

This program is a simple editing program to modify values in data files with large record lengths (i.e., those with lengths > 80). The program will change values of variable (i), subject (j). The program will also list the original data and the revised data in any output format specified, if requested.

User Considerations and Procedures:

1. Program expects data in a row x column (R x C) matrix form. Each line of raw data would have C (column) elements (all variables for subject (j)).
2. A listing of the data file can be obtained before editing. Option: 1 if raw data printout is desired, 0 for no printout. A listing of the revised data can only be obtained by rerunning the program after the necessary modifications have been made.
3. Data listings can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
4. If the option for data listing is used, the program will ask for the desired output format. When the raw data have been listed, enter 1 to end EDIT or 0 to continue with editing.
5. For each editing change desired, enter record number, variable number, and desired correction separating each by commas. For example, to change variable 22 of subject 10 from 39.5 to 29.5, type 10, 22, 29.5. Continue with the same procedure for other corrections, if any. When there are no more corrections to be made, type -999 -999 -999.
6. Parameters required:
 - a. number of variables (maximum 100)
 - b. number of subjects (maximum 32767)
 - c. name of data file
 - d. format and record length of file (see DA30)
 - e. format used to list data (for legibility of data files)
 - f. editing parameters and corrections

RU,EDIT
ENTER NAME OF DATA FILE
#FATAA
ENTER FORMAT OF DATA
(8(2X,F6.2))
ENTER NUMBER OF VARIABLES
8
ENTER NUMBER OF SUBJECTS(RECORDS)
32
ENTER THE RECORD LENGTH AS IN DA30
64
ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER
1
ENTER 1 FOR DATA LISTING
0
ENTER IN ORDER 'RECORD #, VARIABLE #, CORRECTION
!E, TO CHANGE THE VALUE OF VARIABLE 5 OF SUBJECT 10
TO 29.5 TYPE
10,5,29.5
WHEN YOU ARE THROUGH WITH ALL CORRECTIONS TYPE IN
-999,-999,-999
3,5,678.1
5,8,599.9
15,6,435.12
24,1,39.5
31,2,45.6
-999,-999,-999
EDITING FINISHED
:

*EDIT T=00003 IS ON CR00002 USING 00010 BLKS R=0000

```
0001 FTM4,L
0002 PROGRAM EDIT
0003 COMMON IB(272),IBUF(256),INAME(3),IFMT1(20),IFMT2(20),X(100)
0004 WRITE(1,1)
0005 1 FORMAT("ENTER NAME OF DATA FILE")
0006 READ(1,2) INAME
0007 2 FORMAT(3A2)
0008 WRITE(1,3)
0009 3 FORMAT("ENTER FORMAT OF DATA")
0010 READ(1,4) IFMT1
0011 4 FORMAT(20A2)
0012 WRITE(1,13)
0013 13 FORMAT("ENTER NUMBER OF VARIABLES")
0014 READ(1,*) NVAR
0015 WRITE(1,11)
0016 11 FORMAT("ENTER NUMBER OF SUBJECTS(RECORDS)")
0017 READ(1,*) NSUB
0018 WRITE(1,88)
0019 88 FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0020 READ(1,*) LENGTH
0021 LEN=LENGTH/2
0022 IF((LEN*2).NE.LENGTH) LEN=LEN+1
0023 LENGTH=LEN
0024 IDCBS=LENGTH
0025 IF(LENGTH.LT.144) IDCBS=144
0026 CALL OPEN(IB,IER,INAME,3,0,-2,IDCBS)
0027 IF(IER.GE.0) GO TO 100
0028 WRITE(1,5) INAME,IER
0029 5 FORMAT(3A2," FAILED TO OPEN , IER = ",I5)
0030 STOP 5
0031 100 WRITE(1,6)
0032 6 FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER")
0033 READ(1,*) IUNIT
0034 WRITE(1,7)
0035 7 FORMAT("ENTER 1 FOR DATA LISTING")
0036 READ(1,*) ICOM
0037 IF(ICOM.NE.1) GO TO 1100
0038 10 FORMAT("ENTER OUTPUT FORMAT DISIRED")
0039 1000 WRITE(1,10)
0040 READ(1,4) IFMT2
0041 DO 1012 J=1,NSUB
0042 CALL READF(IB,IER,IBUF)
0043 CALL CODE
0044 READ(IBUF,IFMT1)(X(I),I=1,NVAR)
0045 WRITE(IUNIT,133)
0046 133 FORMAT(5X)
0047 1012 WRITE(IUNIT,IFMT2) (X(I),I=1,NVAR)
0048 WRITE(1,17)
0049 17 FORMAT("ENTER ONE TO END EDIT")
0050 READ(1,*) ICOM
0051 IF(ICOM.EQ.1) STOP 17
```

```

0052 1100 WRITE(1,18)
0053 18   FORMAT("ENTER IN ORDER 'RECORD #, VARIABLE #, CORRECTION",/
0054      $"IE, TO CHANGE THE VALUE OF VARIABLE 5 OF SUBJECT 10",/
0055      $" TO 29.5 TYPE",/,10X," 10.5,29.5",/,"WHEN YOU ARE THROUGH",
0056      $" WITH ALL CORRECTIONS TYPE IN ",/,10X,"-999,-999,-999")
0057      DO 1111 J=1,10000
0058      READ(1,*) K,L,Z
0059      IF(K.EQ.-999) GO TO 999
0060      CALL READF(IB,IER,IBUF,IDCBS,LEN,K)
0061      CALL CODE
0062      READ(IBUF,IFMT1) (X(I),I=1,NVAR)
0063      X(L)=Z
0064      CALL CODE
0065      WRITE(IBUF,IFMT1) (X(I),I=1,NVAR)
0066      CALL WRITF(IB,IER,IBUF,0,-1)
0067      CALL RWNDF(IB)
0068 1111  CONTINUE
0069 999   WRITE(1,16)
0070 16   FORMAT("EDITING FINISHED")
0071      END
0072      ENDS

```

TRAFM (Data Transformation)

Purpose:

This program is used to create a new data set based on a transformation of an old data set. TRAFM can transform data that are in matrix form or in sequential (continuous) form. The program performs the following 11 transformations:

- 1 = reciprocal ($1/x$)
- 2 = square root
- 3 = $\log_{10}$
- 4 = Z score $\frac{x - \text{mean}}{SD}$ using mean and standard deviation of all desired variables
- 5 = $\frac{1}{2} \log_{10} (1 + x)/(1 - x)$
- 6 = $x + \text{constant}$
- 7 = $x - \text{constant}$
- 8 = $x * \text{constant}$
- 9 = $x / \text{constant}$
- 10 = $2 \arcsin (x^{.5}) = 2 \arcsin \sqrt{x}$
- 11 = Z score by individual means and standard deviations

User Considerations and Procedures:

1. Program creates a new data file. Caution should be taken to format the new data to correspond to the requested transformation. For example, reciprocal data will require decimal notation.
2. Program needs to know the type of data file which will be used. Enter 1 if data are in sequential form, enter 0 if in matrix form.
3. For data in matrix form:
 - a. program asks for number of subjects twice. Respond both times with the number of rows in the matrix file
 - b. program asks for number of variables per subject (columns). Respond with the number of columns in the matrix file (maximum 30)
 - c. program asks if the same transformation is desired for all variables. Respond 1 for yes, 0 for no
 - d. if a 0 response was given to the above (c), program asks for the variable number (column) that is to be transformed. Then, program asks if more transformations are desired. Respond 1 for yes, or 0 for no. On a response of 1, the sequence is repeated

4. For data in a sequential form: (program expects data to index for subjects first, then for variables, with one subject per line).
 - a. program asks for number of subjects in TRAFM file; respond with the total number of records in the data file
 - b. program asks for number of variables in data file. This allows some leeway in breaking up or partitioning the transform file. If there is no logical way to partition the file, enter 1 for only one variable. In most cases, number of variables is the number of groups of subjects
 - c. same as 3-c
 - d. same as 3-d
 - e. programs ask for number of subjects for each variable. Respond with the number of subjects in each group
5. Parameters required:
 - a. type of transform required. Enter the numerical code which corresponds to the correct transformation. When the transformation is finished, enter 0 to end the program, or enter 1 to perform another transformation.
 - b. name of old file
 - c. name of new TRAFM file
 - d. format and record length of old data file (see DA30)
 - e. format and record length of new data file (see DA30)
 - f. other parameters required for certain transformation such as largest positive number of constant to be used. For more information, see comments
6. There is no printout of the original or transformed data.

Comments:

Uses and special considerations for each transformation.

1. Reciprocal

This is used to normalize data when the raw data are skewed to the right. If a raw value is 0, the program arbitrarily assigns a value of 1. This transformation improves homoscedasticity of the distribution.

2. Square Root

This is used to normalize rightly skewed data. Program asks for the largest negative number in absolute value (C). The actual transformation is $\text{SQRT}(x + C)$ when x is less than or equal to ten. This transformation improves the homoscedasticity of the distribution.

3. Log_{10}

This is the strongest transformation to normalize rightly skewed data. It may pull in the right tail too far and create outliers on the left side of the distribution. When this occurs, transformation 1 or 2 above is warranted. Program requires that the largest negative number in absolute value (C) be inputted. The actual transformation is $\log(x + C + 1)$. The log transform is the most powerful in improving homoscedasticity and can be used solely for this purpose.

4. Z Score

This transformation can be performed by using the mean and standard deviation of all the variables in the data file or by the mean and standard deviation of the specific variable (column) to be transformed. Respond 1 if the transform should be based on all data, or 0 if calculations are to be based on only the specified transform variable.

5. $\frac{1}{2} \log((1 + x)/(1 - x))$

This is used to transform left skewed distributions or platykurtic distributions. Program requires highest positive number (C) to be given and the highest negative number in absolute value (C₂). The actual transformation is:

$$\frac{1}{2} \log((1 + x')/(1 - x')), \text{ where } x' = (x + C_2)/(C_2 + C + 1).$$

6. $x + \text{Constant}$

This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

7. $x - \text{Constant}$

This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

8. $x * \text{Constant}$

This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

9. $x / \text{Constant}$

This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

10. $2 \arcsin \sqrt{x}$

This transformation is applicable for left-skewed distributions or platykurtic distributions. Data must be proportional data; i.e., $0 \leq x \leq 1$. This transformation is useful in many non-parametric procedures.

11. Individual Z Score

This transformation is done by standardization of desired variables by their individual means and standard deviations.

Test Data:

Program was tested by comparing data output with calculator analysis and the Statistical Analysis System. Transformation involving logs or sines are accurate to five digits; other transformations are accurate to six digits.

RU, TRAFM

PROGRAM TO TRANSFORM DATA

TYPE OF TRANSFORM

0 = STOP
1 = RECIPICAL 1/X
2 = SQUARE ROOT (X)**.5
3 = LOG(10)X
4 = Z SCORE = (X-MEAN)/SD
5 = 1/2 LOG ((1+X)/(1-X))
6 = X + CONSTANT
7 = X - CONSTANT
8 = X * CONSTANT
9 = X / CONSTANT
10 = 2 ARCSIN (X**.5) - MUST BE PROPORTIONAL DATA<15>
11 = Z SCORE BY INDIVIDUAL VARIABLE MEAN AND SD
ENTER BY NUMBER THE TRANSFORMED DESIRED:

11

DATA FILENAME

#FATAA

DATA FORMAT

(8(2X,F6.2))

NEW DATA FILENAME

#ZSCR

ENTER THE RECORD LENGTH AS IN DA30

64

INPUT NUMBER OF SUBJECTS IN TRAFM FILE

32

NUMBER OF VARIABLES PER SUBJECT :

8

DO YOU WISH TRANSFORMATIONS ON ALL VARIABLES, 1 = YES , 0 - NO

1

TYPE OF DATA FILE 1 = CONTINUOUS , 0 = MATRIX :

0

NUMBER OF SUBJECTS :

32

TRANSFORMATION TYPE 11 IS FINISHED

TO STOP ENTER 0, FOR MORE ENTER ANY OTHER NUMBER

0

TRAFM : STOP 0000

:

*TRAFH T=00004 IS ON CR00002 USING 00053 BLKS R=0449

```

0001 FTH4
0002 PROGRAM TRAFH
0003 DIMENSION NAME(3), INAME(3), IFMT(20), IDATA(30), DTA(30), IZ(30)
0004 DIMENSION IB(272), IC(272), IBUF(256), ICF(256), ISIZE(2)
0005 DIMENSION SUM1(30), SUM3(30), XBR(30), STD(30)
0006 DIMENSION IFMT1(20)
0007 50 WRITE(1,277)
0008 277 FORMAT(//, " PROGRAM TO TRANSFORM DATA ",//,/,
0009 C" TYPE OF TRANSFORM" //,
0010 C" 0 = STOP" //,
0011 C" 1 = RECIPICAL 1/X" //,
0012 C" 2 = SQUARE ROOT (X,/,**,.5" //,
0013 C" 3 = LOG(10)X" )
0014 WRITE(1,4405)
0015 4405 FORMAT ( " 4 = Z SCORE (X-MEAN)/SD" //,
0016 C" 5 = 1/2 LOG ((1+X)/(1-X))" //,
0017 C" 6 = X + CONSTANT" //,
0018 C" 7 = X - CONSTANT" //,
0019 C" 8 = X * CONSTANT" //,
0020 C" 9 = X / CONSTANT" )
0021 WRITE(1,4411)
0022 4411 FORMAT ( "10 = 2 ARCSIN (X*.5) - MUST BE PROPORTIONAL DATA<15>"
0023 C,/, " 11 = Z SCORE BY INDIVIDUAL VARIABLE MEAN AND SD" //,
0024 C" ENTER BY NUMBER THE TRANSFORMED DESIRED: " )
0025 READ(1,*) ITEST
0026 IF(ITEST.EQ.0)GO TO 61
0027 WRITE(1,4413)
0028 4413 FORMAT ( "ENTER INPUT DATA FILENAME" )
0029 READ(1,30)NAME
0030 30 FORMAT(3A2)
0031 WRITE(1,4414)
0032 4414 FORMAT ( " DATA FORMAT" )
0033 READ(1,130)IFMT
0034 130 FORMAT(20A2)
0035 WRITE(1,4238)
0036 4238 FORMAT("ENTER THE INPUT RECORD LENGTH AS IN DA30")
0037 READ(1,*)LENGTH
0038 WRITE(1,4415)
0039 4415 FORMAT ( " NEW DATA FILENAME" )
0040 READ(1,30)INAME
0041 WRITE(1,4673)
0042 4673 FORMAT("ENTER OUTPUT DATA FORMAT")
0043 READ(1,130) IFMT1
0044 IDCBS=256
0045 ISIZE(1)=-1
0046 ISIZE(2)=LENGTH
0047 CALL CREAT(IC,IER1,INAME,ISIZE,2,0,-2,IDCBS)
0048 IF(IER1.GE.0) GO TO 379
0049 WRITE(1,981)
0050 981 FORMAT(" INPUT NUMBER OF SUBJECTS IN TRAFH FILE")

```

```

0051      READ(1,*) NSU
0052      SIZE=LENGTH
0053      XNSU=NSU
0054      SIZE=XNSU*SIZE/128. + 1.
0055      ISIZE(1)=SIZE
0056      CALL CREAT(IC,IER,INAME,ISIZE,2,0,-2,IDCBS)
0057      IF(IER.GE.0) GO TO 379
0058 879    WRITE(1,378) INAME,IER
0059      CALL CLOSE(IB)
0060      STOP 3715
0061 379    K4=0
0062      CALL OPEN(IB,IERR,NAME,3,0,-2,IDCBS)
0063      IF(IERR.GE.0) GO TO 377
0064      WRITE(1,378) NAME,IERR
0065 378    FORMAT(1X,3A2," FAILED TO OPEN, ERROR # ",15)
0066      CALL PURGE(IC,IER,INAME)
0067      STOP 371
0068 377    WRITE(1,4416)
0069 4416    FORMAT ( " NUMBER OF VARIABLES PER SUBJECT :   ")
0070      READ(1,*) IV
0071      WRITE(1,4417)
0072 4417    FORMAT(" DO YOU WISH TRANSFORMATIONS ON ALL VARIABLES,"
0073            1," 1 = YES , 0 = NO ")
0074      READ(1,*) IFT
0075      IF(IFT.EQ.0)GO TO 20
0076      DO 19 K=1,IV
0077 19      IDATA(K)=1
0078      GO TO 31
0079 20      DO 21 K=1,IV
0080 21      IDATA(K)=0
0081 22      WRITE(1,4418)
0082 4418    FORMAT ( " TRANSFORM ON VARIABLE #   ")
0083      READ(1,*) ITRN
0084      IDATA(ITRN)=1
0085      WRITE(1,4419)
0086 4419    FORMAT ( " ANY MORE TRANSFORMS 1 = YES , 0 = NO ")
0087      READ(1,*) ITRN
0088      IF(ITRN.EQ.1)GO TO 22
0089 31      WRITE(1,4420)
0090 4420    FORMAT ( " TYPE OF DATA FILE 1 = CONTINUOUS , 0 = MATRIX :   ")
0091      READ(1,*) IFLE
0092      IF(IFLE.EQ.1.AND.ITEST.EQ.11) GO TO 11
0093      IF(IFLE.EQ.1)GO TO 32
0094      WRITE(1,4421)
0095 4421    FORMAT ( " NUMBER OF SUBJECTS   ")
0096      READ(1,*) NSUB
0097      IDPT=IV
0098      IV=0
0099      GO TO 33
0100 32      K4=K4+1
0101      WRITE(1,4422) K4
0102 4422    FORMAT ( " NUMBER OF SUBJECTS FOR VARIABLE # ",15 )
0103      READ(1,*) NSUB
0104      IDPT=1
0105 33      GO TO (1,2,3,4,5,6,7,8,9,10,11)ITEST

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```

0106 1      DO 100 K=1, NSUB
0107      CALL READF(IB, IER, IBUF)
0108      CALL CODE
0109      READ(IBUF, IFMT)(DTA(J), J=1, IDPT)
0110      IF(K4.EQ.0)GO TO 102
0111      J=K4
0112      GO TO 103
0113 102     DO 101 J=1, IDPT
0114 103     IF(IDATA(J).EQ.0)GO TO 101
0115         IF(K4.NE.0)J=1
0116         IF(DTA(J).EQ.0)DTA(J)=DTA(J)+1
0117         DTA(J)=1/DTA(J)
0118 101     CONTINUE
0119         CALL CODE
0120         WRITE(ICUF, IFMT1)(DTA(J), J=1, IDPT)
0121         CALL WRITF(IC, IE, ICUF)
0122 100     CONTINUE
0123         GO TO 60
0124 2       WRITE(1, 4423)
0125 4423    FORMAT (" ENTER THE LARGEST NEG. VALUE AS AN ABSOL. NUMBER : ")
0126         READ(1, *) C
0127         DO 200 K=1, NSUB
0128         CALL READF(IB, IE, IBUF)
0129         CALL CODE
0130         READ(IBUF, IFMT)(DTA(J), J=1, IDPT)
0131         IF(K4.EQ.0)GO TO 202
0132         J=K4
0133         GO TO 203
0134 202     DO 201 J=1, IDPT
0135 203     IF(IDATA(J).EQ.0)GO TO 201
0136         IF(K4.NE.0)J=1
0137         IF(DTA(J).LT.10)DTA(J)=DTA(J)+.5+C
0138         DTA(J)=(DTA(J)**.5)
0139 201     CONTINUE
0140         CALL CODE
0141         WRITE(ICUF, IFMT1)(DTA(J), J=1, IDPT)
0142         CALL WRITF(IC, IE, ICUF)
0143 200     CONTINUE
0144         GO TO 60
0145 3       WRITE(1, 4424)
0146 4424    FORMAT (" ENTER LARGEST NEG. NUMBER AS AN ABSOL. NUMBER : ")
0147         READ(1, *) C
0148         DO 300 K=1, NSUB
0149         CALL READF(IB, IER, IBUF)
0150         CALL CODE
0151         READ(IBUF, IFMT)(DTA(J), J=1, IDPT)
0152         IF(K4.EQ.0)GO TO 302
0153         J=K4
0154         GO TO 303
0155 302     DO 301 J=1, IDPT
0156 303     IF(IDATA(J).EQ.0)GO TO 301
0157         IF(K4.NE.0)J=1
0158         DTA(J)=ALOG(DTA(J)+1+C)
0159 301     CONTINUE

```

```

0160      CALL CODE
0161      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0162      CALL WRITF(IC,IE,ICUF)
0163 300    CONTINUE
0164      GO TO 60
0165 5      WRITE(1,4425)
0166 4425   FORMAT ( " TYPE THE HIGHEST POSITIVE NUMBER : ")
0167      READ(1,*) C
0168      WRITE(1,4426)
0169 4426   FORMAT ( " TYPE THE HIGHEST NEG. # AS AN ABSOL. NUMBER : ")
0170      READ(1,*) C1
0171      DO 500 K=1,NSUB
0172      CALL READF(ID,IRT,IBUF)
0173      CALL CODE
0174      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0175      IF(K4.EQ.0)GO TO 502
0176      J=K4
0177      GO TO 503
0178 502    DO 501 J=1,IDPT
0179 503    IF(IDATA(J).EQ.0)GO TO 501
0180      IF(K4.NE.0)J=1
0181      DTA(J)=(DTA(J)+C1)/(C+C1+1)
0182      DTA(J)=(ALOG((1+DTA(J))/(1-DTA(J))))*.5
0183 501    CONTINUE
0184      CALL CODE
0185      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0186      CALL WRITF(IC,IEV,ICUF)
0187 500    CONTINUE
0188      GO TO 60
0189 6      WRITE(1,4427)
0190 4427   FORMAT ( " TYPE CONSTANT TO BE USED : ")
0191      READ(1,*) C
0192      DO 600 K=1,NSUB
0193      CALL READF(ID,IER,IBUF)
0194      CALL CODE
0195      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0196      IF(K4.EQ.0)GO TO 602
0197      J=K4
0198      GO TO 603
0199 602    DO 601 J=1,IDPT
0200 603    IF(IDATA(J).EQ.0)GO TO 601
0201      IF(K4.NE.0)J=1
0202      DTA(J)=DTA(J)+C
0203 601    CONTINUE
0204      CALL CODE
0205      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0206      CALL WRITF(IC,IER,ICUF)
0207 600    CONTINUE
0208      GO TO 60
0209 7      WRITE(1,4428)
0210 4428   FORMAT ( " TYPE CONSTANT TO BE USED : ")
0211      READ(1,*) C
0212      DO 700 K=1,NSUB
0213      CALL READF(ID,IER,IBUF)
0214      CALL CODE

```

```

0215      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0216      IF(K4.EQ.0)GO TO 702
0217      J=K4
0218      GO TO 703
0219 702   DO 701 J=1,IDPT
0220 703   IF(IDATA(J).EQ.0)GO TO 701
0221      IF(K4.NE.0)J=1
0222      DTA(J)=DTA(J)-C
0223 701   CONTINUE
0224      CALL CODE
0225      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0226      CALL WRITF(IC,IER,ICUF)
0227 700   CONTINUE
0228      GO TO 60
0229 8     WRITE(1,4429)
0230 4429  FORMAT( " TYPE CONSTANT TO BE USED : ")
0231      READ(1,*) C
0232      DO 800 K=1,NSUB
0233      CALL READF(IB,IER,IBUF)
0234      CALL CODE
0235      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0236      IF(K4.EQ.0)GO TO 802
0237      J=K4
0238      GO TO 803
0239 802   DO 801 J=1,IDPT
0240 803   IF(IDATA(J).EQ.0)GO TO 801
0241      IF(K4.NE.0)J=1
0242      DTA(J)=DTA(J)*C
0243 801   CONTINUE
0244      CALL CODE
0245      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0246      CALL WRITF(IC,IER,ICUF)
0247 800   CONTINUE
0248      GO TO 60
0249 9     WRITE(1,960)
0250 960   FORMAT( " TYPE CONSTANT TO BE USED : ")
0251      READ(1,*) C
0252      DO 900 K=1,NSUB
0253      CALL READF(IB,IER,IBUF)
0254      CALL CODE
0255      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0256      IF(K4.EQ.0)GO TO 902
0257      J=K4
0258      GO TO 903
0259 902   DO 901 J=1,IDPT
0260 903   IF(IDATA(J).EQ.0)GO TO 901
0261      IF(K4.NE.0)J=1
0262      DTA(J)=DTA(J)/C
0263 901   CONTINUE
0264      CALL CODE
0265      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0266      CALL WRITF(IC,IER,ICUF)
0267 900   CONTINUE
0268      GO TO 60
0269 10    DO 1000 K=1,NSUB
0270      CALL READF(IB,IER,IBUF)
0271      CALL CODE

```

```

0272      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0273      IF(K4.EQ.0)GO TO 1002
0274      J=K4
0275      GO TO 1003
0276 1002  DO 1001 J=1,IDPT
0277 1003  IF(IDATA(J).EQ.0)GO TO 1001
0278      IF(K4.NE.0)J=1
0279      IF(DTA(J).LE.0.OR.DTA(J).GE.1)GO TO 1010
0280      DTA(J)=2*ATAN(DTA(J)/(1-DTA(J)))*.5)
0281 1001  CONTINUE
0282      CALL CODE
0283      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0284      CALL WRITE(IC,IER,ICUF)
0285 1000  CONTINUE
0286      GO TO 60
0287 1010  WRITE(1,951)
0288 951    FORMAT(" DATA MUST BE PROPORTIONAL - RECHECK DATA !!!", , "
0289      1TRANSFORM ABORTED ")
0290      GO TO 62
0291 4      IF(IFLE.EQ.0)GO TO 450
0292      IF(IFLE.GT.1)GO TO 420
0293 450    H=0
0294      SUM=0
0295      SUM2=0
0296      WRITE(1,950)
0297 950    FORMAT(" DO YOU WANT THE MEAN CALCUL. ON ALL DATA POINTS ?",
0298      1/" 1 = YES , 0 = NO ")
0299      READ(1,*) C
0300 420    DO 400 K=1,NSUB
0301      CALL READF(IB,IER,IBUF)
0302      CALL CODE
0303      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0304      IF(C.EQ.0)GO TO 401
0305      DO 402 J=1,IDPT
0306      H=H+1
0307      SUM=SUM+DTA(J)
0308      SUM2=SUM2+DTA(J)**2
0309 402    CONTINUE
0310      GO TO 400
0311 401    IF(K4.EQ.0)GO TO 421
0312      J=K4
0313      GO TO 422
0314 421    DO 400 J=1,IDPT
0315 422    IF(IDATA(J).EQ.0)GO TO 400
0316      IF(K4.NE.0)J=1
0317      H=H+1
0318      SUM=SUM+DTA(J)
0319      SUM2=SUM2+DTA(J)**2
0320 400    CONTINUE
0321      IF(IFLE.EQ.0)GO TO 423
0322      IFLE=IFLE+1
0323      IZ(K4)=NSUB
0324      IF(IFLE.GT.IV)GO TO 423
0325      GO TO 32

```

```

0326 423 XN=N
0327 XMEAN=SUN/XN
0328 SD=SQRT((SUM2-SUN*SUN/XN)/(XN-1.))
0329 CALL RWHDF(IB)
0330 IX=IV
0331 IV=0
0332 K1=0
0333 IF(IFLE.EQ.0)GO TO 431
0334 DO 410 K1=1,IX
0335 NSUB=IZ(K1)
0336 431 DO 410 K=1,NSUB
0337 CALL READF(IB,IER,IBUF)
0338 CALL CODE
0339 READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0340 IF(IFLE.EQ.0)GO TO 433
0341 J=K1
0342 GO TO 432
0343 433 DO 411 J=1,IDPT
0344 432 IF(IDATA(J).EQ.0)GO TO 411
0345 IF(IFLE.NE.0)J=1
0346 DTA(J)=(DTA(J)-XMEAN)/SD
0347 411 CONTINUE
0348 CALL CODE
0349 WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0350 CALL WRITF(IC,IER,ICUF)
0351 410 CONTINUE
0352 GO TO 60
0353 11 IV=IDPT
0354 NSUB=NSU
0355 IF(IFLE.NE.1) GO TO 63
0356 N=0
0357 DO 3256 I=1,IV
0358 SUM=0.
0359 SUM2=0.
0360 WRITE(1,4422) I
0361 READ(1,*) NSUB
0362 DO 1027 J=1,NSUB
0363 N=N+1
0364 CALL READF(IB,IER,IBUF,256,LEN,N)
0365 CALL CODE
0366 READ(IBUF,IFMT) DAT
0367 SUM=SUM+DAT
0368 SUM2=SUM2+DAT*DAT
0369 1027 CONTINUE
0370 XSUB=NSUB
0371 XBAR=SUM/XSUB
0372 SD=SQRT((SUM2-SUM*SUM/XSUB)/(XSUB-1.))
0373 CALL RWHDF(IB)
0374 DO 1034 J=1,NSUB
0375 N=N-NSUB+J
0376 CALL READF(IB,IER,IBUF)
0377 CALL CODE
0378 READ(IBUF,IFMT) DAT
0379 IF(IDATA(I).EQ.0) GO TO 9651
0380 DAT=(DAT-XBAR)/SD
0381 9651 CALL CODE

```

```

0382      WRITE(ICUF,IFMT1) DAT
0383      M=N-NSUB+J
0384      CALL WRITF(IC,IER,ICUF,0,M)
0385  1034  CONTINUE
0386  3256  CONTINUE
0387      GO TO 62
0388  63    XSUB=MSUB
0389      DO 64 I=1,IV
0390      SUM1(I)=0.
0391  64    SUM3(I)=0.
0392      DO 65 I=1,NSUB
0393      CALL READF(IB,IER,IBUF)
0394      CALL CODE
0395      READ(IBUF,IFMT) (DTA(J),J=1,IV)
0396      DO 66 J=1,IV
0397      SUM1(J)=SUM1(J)+DTA(J)
0398      SUM3(J)=SUM3(J)+DTA(J)*DTA(J)
0399  66    CONTINUE
0400  65    CONTINUE
0401      DO 67 J=1,IV
0402      XBR(J)=SUM1(J)/XSUB
0403  67    STD(J)=SQRT((SUM3(J)-SUM1(J)*SUM1(J)/XSUB)/(XSUB-1.))
0404      CALL RWNDF(IB)
0405      DO 68 I=1,NSUB
0406      CALL READF(IB,IER,IBUF)
0407      CALL CODE
0408      READ(IBUF,IFMT) (DTA(J1),J1=1,IV)
0409      DO 69 J=1,IV
0410      IF(IDATA(J).EQ.0) GO TO 69
0411      DTA(J)=(DTA(J)-XBR(J))/STD(J)
0412  69    CONTINUE
0413      CALL CODE
0414      WRITE(ICUF,IFMT1) (DTA(J),J=1,IV)
0415      CALL WRITF(IC,IER,ICUF,0,I)
0416  68    CONTINUE
0417      GO TO 62
0418  60    IV=IV-1
0419      IF(IV.GT.0)GO TO 32
0420  62    CALL CLOSE (IB,IER)
0421      CALL CLOSE(IC)
0422      WRITE(1,4567) ITEST
0423  4567  FORMAT(" TRANSFORMATION TYPE ",I5," IS FINISHED",/,
0424      1" TO STOP ENTER 0, FOR MORE ENTER ANY OTHER NUMBER")
0425      READ(1,*) LTEST
0426      IF(LTEST.EQ.0) GO TO 61
0427      GO TO 50
0428  61    STOP
0429      END
0430      END$

```


II. PARAMETRIC STATISTICS

A. Descriptive Statistics

DSPD (Parametric Descriptive Statistics)

Purpose:

This program describes parametric data by various statistics including mean, standard deviation, skewness, kurtosis, and range.

User Consideration and Procedures:

1. Data files can either be in matrix form with equal number of variables per subject, or in sequential form, n_j , where n_j equals number of subjects for variables j .
2. For data files in matrix form, the variables per subject constitute a record in the data file. A printout of raw data would show j observations per line (subject). For data files in sequential form, read in all subjects under variable 1, then index to variable 2, etc. Raw data printout shows 1 observation per line.
3. The data can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
4. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#3).
5. Parameters required:
 - a. number of variables (maximum 30)
 - b. data file name
 - c. format and record length of data file
 - d. type of data:
1 for continuous (sequential)
0 for matrix
 - e. for continuous data file - number of subjects for each variable
 - f. for matrix data file - number of subjects

6. Printout gives the following information for each variable:

- a. variable number
- b. number of subjects
- c. mean
- d. standard deviation
- e. skewness
- f. kurtosis
- g. range

Test Data:

Program was tested by comparing data output with results obtained from hardwired programmed functions of a Texas Instruments calculator.

RU,DS7D
NUMBER OF VARIABLES :
8
INPUT FILENAME
#FATAA
ENTER DATA FORMAT
(8(2X,F6.2))
ENTER THE RECORD LENGTH AS IN TA30
64
TYPE OF DATA 1 = CONTINUOUS , 0 = MATRIX:
0
ENTER # OF SUBJECTS
32
ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT
6
:

VARIABLE #	1
NUMBER OF SUBJECTS =	32
MEAN =	42.750
STANDARD DEVIATION =	21.691
SKEWNESS =	.581
KURTOSIS =	-1.204
RANGE =	63.000

VARIABLE #	2
NUMBER OF SUBJECTS =	32
MEAN =	48.812
STANDARD DEVIATION =	23.952
SKEWNESS =	-.170
KURTOSIS =	-1.384
RANGE =	75.000

VARIABLE #	3
NUMBER OF SUBJECTS =	32
MEAN =	342.375
STANDARD DEVIATION =	380.971
SKEWNESS =	1.160
KURTOSIS =	.247
RANGE =	1406.000

VARIABLE #	4
NUMBER OF SUBJECTS =	32
MEAN =	632.781
STANDARD DEVIATION =	464.372
SKEWNESS =	1.544
KURTOSIS =	2.590
RANGE =	2122.000

VARIABLE #	5
NUMBER OF SUBJECTS =	32
MEAN =	616.656
STANDARD DEVIATION =	429.506
SKEWNESS =	1.114
KURTOSIS =	.767
RANGE =	1730.00

VARIABLE #	6
NUMBER OF SUBJECTS -	32
MEAN -	672.687
STANDARD DEVIATION -	543.445
SKEWNESS -	1.776
KURTOSIS -	3.491
RANGE -	2567.000

VARIABLE #	7
NUMBER OF SUBJECTS -	32
MEAN -	565.875
STANDARD DEVIATION -	376.128
SKEWNESS -	.354
KURTOSIS -	-1.256
RANGE -	1264.000

VARIABLE #	8
NUMBER OF SUBJECTS -	32
MEAN -	601.625
STANDARD DEVIATION -	646.360
SKEWNESS -	2.235
KURTOSIS -	5.985
RANGE -	3149.000

*DSPD T=00003 IS ON CR00002 USING 00014 BLKS R=0000

```
0001 FTH4
0002 PROGRAM DSPD
0003 DIMENSION NAME(3)
0004 DOUBLE PRECISION DAT(30),SUM(30),SUM2(30),SUM3(30),
0005 XSUM4(30),SMEAN(30),SKEW(30),AKURT(30),SD(30),RH(30),RL(30)
0006 DIMENSION IB(272),IBUF(256),IFMT(20),NS(30)
0007 WRITE(1,4400)
0008 4400 FORMAT ( " NUMBER OF VARIABLES : " )
0009 READ(1,*) NV
0010 WRITE(1,4401)
0011 4401 FORMAT ( " INPUT FILENAME" )
0012 READ(1,1)NAME
0013 1 FORMAT(3A2)
0014 WRITE(1,3458)
0015 3458 FORMAT(" ENTER DATA FORMAT ")
0016 READ(1,987) IFMT
0017 987 FORMAT(20A2)
0018 CALL OPEN(IB,IERR,NAME)
0019 IF(IERR.GE.0) GO TO 77
0020 WRITE(1,78) NAME,IERR
0021 78 FORMAT(5X,3A2," FAILED TO OPEN ",15," ERROR #")
0022 STOP
0023 77 WRITE(1,4403)
0024 4403 FORMAT ( " TYPE OF DATA 1 = CONTINUOUS , 0 = MATRIX : " )
0025 READ(1,*) ITYP
0026 IF(ITYP.NE.0) GO TO 99
0027 WRITE(1,100)
0028 100 FORMAT( "ENTER # OF SUBJECTS ")
0029 READ(1,*) NSUB
0030 GO TO 20
0031 99 K4=NV
0032 IF(ITYP.EQ.0)GO TO 20
0033 K4=NV
0034 NV=1
0035 DO 3 J1=1,K4
0036 WRITE(1,4404) J1
0037 4404 FORMAT ( " NUMBER OF SUBJECTS FOR VARIABLE # ",15 )
0038 READ(1,*) NSUB
0039 20 DO 2 K=1,NSUB
0040 CALL READF(IB,IERR,IBUF)
0041 CALL CODE
0042 READ(IBUF,IFMT)(DAT(J),J=1,NV)
0043 IF(K.GT.1)GO TO 10
0044 DO 11 J=1,NV
0045 J2=J
0046 IF(ITYP.EQ.1)J2=J1
0047 RH(J2)=DAT(J)
0048 11 RL(J2)=DAT(J)
0049 10 DO 2 J=1,NV
```



```

0050      J2=J
0051      IF(ITYP.EQ.1)J2=J1
0052      SUM(J2)=SUM(J2)+DAT(J)
0053      SUM2(J2)=SUM2(J2)+DAT(J)**2
0054      IF(RH(J2).LT.DAT(J))RH(J2)=DAT(J)
0055      IF(RL(J2).GT.DAT(J))RL(J2)=DAT(J)
0056  2      CONTINUE
0057      DO 12 J=1,NV
0058      J2=J
0059      IF(ITYP.EQ.1)J2=J1
0060  12      RH(J2)=RH(J2)-RL(J2)+1
0061      DO 3 J=1,NV
0062      J2=J
0063      IF(ITYP.EQ.1)J2=J1
0064      NS(J2)=NSUB
0065      SMEAN(J2)=SUM(J2)/NS(J2)
0066      AA=NS(J2)
0067  3      SD(J2)=(((AA*SUM2(J2))-(SUM(J2)**2))/(AA*(AA-1.))**.5
0068      CALL RUMDF(IB)
0069      IF(ITYP.EQ.0)GO TO 21
0070      DO 5 J1=1,K4
0071      NSUB=NS(J1)
0072  21      DO 4 K=1,NSUB
0073      CALL READF(IB,IERR,IBUF)
0074      CALL CODE
0075      READ(IBUF,IFMT)(DAT(J),J=1,NV)
0076      DO 4 J=1,NV
0077      J2=J
0078      IF(ITYP.EQ.1)J2=J1
0079      SUM3(J2)=SUM3(J2)+(DAT(J)-SMEAN(J2))**3
0080      SUM4(J2)=SUM4(J2)+(DAT(J)-SMEAN(J2))**4
0081  4      CONTINUE
0082      DO 5 J=1,NV
0083      J2=J
0084      IF(ITYP.EQ.1)J2=J1
0085      SKEW(J2)=SUM3(J2)/(NS(J2)*(SD(J2)**3))
0086  5      AKURT(J2)=(SUM4(J2)/(NS(J2)*(SD(J2)**4)))-3
0087      IF(ITYP.EQ.1)NV=K4
0088  873      WRITE(1,543)
0089  543      FORMAT(" ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT")
0090      READ(1,*) IUN1Y
0091      IF((IUN1Y.NE.1).AND.(IUN1Y.NE.6)) GO TO 873
0092      WRITE(IUN1Y,5431)
0093  5431      FORMAT(" ", "VAR#  NSUBJ      MEAN      STD.DEV.",
0094      C"      SKEWNESS      KURTOSIS      RANGE")
0095      WRITE(IUN1Y,14)((J,NS(J),SMEAN(J),SD(J),SKEW(J),AKURT(J),
0096      CRH(J)),J=1,NV)
0097  14      FORMAT(" ",14,2X,15,2X,F10.3,2X,F10.3,2X,F10.3,2X,F10.3,
0098      C2X,F10.3)
0099      CALL CLOSE (IB)
0100      END
0101      END#

```

B. Analysis of Variance and Covariance

AV10 (CR-k) (One-way ANOVA)

Purpose:

This program performs a one-way analysis of variance without replication.

Mathematical Model:

The model for this design is:

$$X_{ij} = \mu + B_j + E_{ij}$$

The hypothesis to be tested is:

$$H_0: B_j = 0 \text{ for all } j$$

The fixed effect model (Model 1) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

Treatment Levels			
b_1	b_2	b_3	b_k

1. There are k levels of treatment B .
2. Subjects are randomly assigned to the treatment levels with each subject designated to receive only one level.

User Considerations and Procedures:

1. A data file must be created with each data point in a sequential file with group one first, then group two, etc. (For example, subject one for treatment b_1 is first record, subject two for treatment b_1 is second record . . ., then subject one for treatment b_2 . . ., subject n for treatment b_j is last record.) A print-out of the raw data file would show only one data point per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of subjects (maximum 32767)
 - b. number of groups (maximum 100)
 - c. number of subjects in each group (maximum 32767)
 - d. name of data file
 - e. format of data file
5. Printout gives:
 - a. raw data by group (optional)
 - b. for each group: N , Σx , Σx^2 , $\bar{X}$, and SD (unbiased estimate)
 - c. ANOVA source table

Comments:

The F-test is analogous to a t-test for uncorrelated data when the design consists of only two treatment levels. The advantage of this ANOVA design is freedom from the restriction of having an equal number of subjects under each level.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, pp. 100-105.

The accuracy of the program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

RU,AV10
 AV10 OR CRK
 NOTE: PROGRAM EXPECTS DATA TO BE IN ONE SEQUENTIAL
 FILE WITH GROUP 1 FIRST THEN GROUP 2, ETC.
 NOTE: MAXIMUM OF 100 GROUPS
 ENTER 1 FOR CRT OUTPUT , 6 FOR LPT
 6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO
 1
 TOTAL NUMBER OF SUBJECTS?
 32
 HOW MANY GROUPS? (maximum 100)
 4
 ENTER NAME OF INPUT DATA FILE:
 #AV20
 ENTER INPUT DATA FORMAT
 (4X,F10.4)

 ENTER SS/GP BEGINNING WITH GP ONE
 HIT RETURN KEY AFTER EACH ENTRY
 8
 8
 8
 8
 AV10 : STOP 0000
 :

GROUP 1 RAW DATA

3.0000
6.0000
3.0000
3.0000
4.0000
5.0000
4.0000
3.0000

GROUP 2 RAW DATA

7.0000
8.0000
7.0000
6.0000
7.0000
8.0000
9.0000
8.0000

GROUP 3 RAW DATA

1.0000
2.0000
2.0000
2.0000
2.0000
3.0000
4.0000
3.0000

GROUP 4 RAW DATA

5.0000
6.0000
5.0000
6.0000
10.0000
9.0000
11.0000
10.0000

GROUP	N	SUMX	SUMX2	MEAN	SD
1	8	31.000	129.000	3.875	1.126
2	8	60.000	456.000	7.500	.926
3	8	19.000	51.000	2.375	.916
4	8	62.000	524.000	7.750	2.493

SOURCE TABLE

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.000			
BETWEEN	171.250	3.000	57.083	24.8768	.00000
WITHIN	64.250	28.000	2.295		

*AV10 T=00003 IS ON CR00002 USING 00012 BLKS R=0000

```

0001 FTH4,L
0002 PROGRAM AV10
0003 DOUBLE PRECISION B(80),BSS,XBAR(80),S(80),DATA,X,SX,BS,BB
0004 DOUBLE PRECISION BBS(80),X,BB,SST,SSBG,SSWG,BDF,WDF,TDF,EMS
0005 DOUBLE PRECISION WMS,F,Z,PS
0006 DIMENSION N(80),INFILE(3),IFMT(20)
0007 DIMENSION IB(272),IBUF(256)
0008 SX=0.
0009 BS=0.
0010 BB=0.
0011 WRITE(1,4400)
0012 4400 FORMAT ( "AV10 OR CRK",/,
0013 C "NOTE: PROGRAM EXPECTS DATA TO BE IN ONE SEQUENTIAL" ,/,
0014 C " FILE WITH GROUP 1 FIRST THEN GROUP 2, ETC.",/,
0015 C "NOTE: MAXIMUM OF 80 GROUPS" ,/,
0016 C "ENTER 1 FOR CRT OUTPUT , 6 FOR LPT " )
0017 READ(1,*) IUNIT
0018 WRITE(1,4405)
0019 4405 FORMAT ( "DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO" )
0020 READ(1,*) IPTO
0021 WRITE(1,4406)
0022 4406 FORMAT ( "TOTAL NUMBER OF SUBJECTS? " )
0023 READ(1,*) NSUB
0024 WRITE(1,4407)
0025 4407 FORMAT ( "HOW MANY GROUPS? (LIMIT IS 80) " )
0026 READ(1,*) NGRP
0027 WRITE(1,4408)
0028 4408 FORMAT ( "ENTER NAME OF INPUT DATA FILE: " )
0029 READ (1,300) INFILE
0030 300 FORMAT (3A2)
0031 WRITE(1,409)
0032 409 FORMAT("ENTER INPUT DATA FORMAT I.E. (F10.4) " )
0033 READ(1,301) IFMT
0034 301 FORMAT(20A2)
0035 IDCBS=256
0036 CALL OPEN (IB,IER,INFILE,3,0,-2,IDCBS)
0037 IF(IER.GE.0) GO TO 870
0038 WRITE(1,655) INFILE,IER
0039 655 FORMAT(5X,3A2," FAILED TO OPEN , IER = ###",15)
0040 STOP 655
0041 870 WRITE(1,4410)
0042 4410 FORMAT ( "ENTER SUBJECTS/GROUP BEGINNING WITH GROUP ONE" ,/,
0043 C "HIT RETURN KEY AFTER EACH ENTRY" )
0044 DO 3 J=1,NGRP
0045 3 READ(1,*) N(J)
0046 90 FORMAT(/," GROUP",3X,"N ",7X,"SUMX",8X,"SUMX2",9X,"MEAN",
0047 $11X,"SD")
0048 DO 5 J=1,NGRP
0049 LL=N(J)
0050 IF(IPTO.EQ.1)WRITE(IUNIT,2)J
0051 2 FORMAT(" GROUP ",12," RAW DATA")
0052 DO 4 K=1,LL
0053 CALL READF(IB,IER,IBUF)
0054 CALL CODE

```

```

0055      READ (IBUF,IFMT) DATA
0056      IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)DATA
0057      SX=8X+DATA
0058      BS=BS+DATA**2
0059      BBS(J)=BBS(J)+DATA**2
0060  4      B(J)=B(J)+DATA
0061      XBAR(J)=B(J)/N(J)
0062      SD(J)=DSQRT((BBS(J)-(B(J)**2)/N(J))/(N(J)-1))
0063  5      CONTINUE
0064      WRITE(IUNIT,90)
0065      DO 50 J=1,NGRP
0066  50      WRITE (IUNIT,100)J,N(J),B(J),BBS(J),XBAR(J),SD(J)
0067  100      FORMAT(1X,I3,3X,I3,4(3X,F10.3))
0068      X=(SX**2)/NSUB
0069      DO 6 L=1,NGRP
0070  6      BB=BB+((B(L)**2)/N(L))
0071      SST=BS-X
0072      SSBG=BB-X
0073      SSUG=BS-BB
0074      BDF=NGRP-1
0075      WDF=NSUB-NGRP
0076      TDF=NSUB-1
0077      BMS=SSBG/BDF
0078      WMS=SSUG/WDF
0079      F=BMS/WMS
0080      CALL FPROB (F,BDF,WDF,Z,PS)
0081      WRITE(IUNIT,875)
0082  875      FORMAT(/,15X,"SOURCE TABLE ",/)
0083      WRITE (IUNIT,200) SST,TDF,SSBG,BDF,BMS,F,PS,SSUG,WDF,WMS
0084  200      FORMAT (/, "  SOURCE          SS          DF",10X,
0085      $"MS          F          P"
0086      $/, "  TOTAL          ",2F13.3,
0087      $/, "  BETWEEN          ",3F13.3,2X,F11.4,2X,F9.5,/,
0088      $"  WITHIN          ",3F13.3)
0089      CALL CLOSE (IB,IER)
0090      STOP
0091      END
0092      END$

```


AV11 (RB-k) (One-way ANOVA, Repeated Measures)

Purpose:

This program performs a one-way analysis of variance with replication either by using matched subjects or repeated measures.

Mathematical Model:

The model for this design is:

$$X_{ij} = \mu + B_j + \pi_i + E_{ij}$$

The hypothesis to be tested is:

$$H_0: B_j = 0 \text{ for all } j$$

The fixed effect model (Model I) was assumed in the deviation of the expected values of the mean squares.

Layout of Design:

Treatment Levels			
b_1	b_2	b_3	b_k

1. There are k levels of treatment B .
2. Subjects are assigned to a treatment so that variability within a treatment is less than the variability among treatments. Homogeneity within treatments may be achieved by using a subject as his own control or by using subjects matched on the basis of a variable that correlates with the dependent variable.

User Considerations and Procedures:

1. A data file must be created with each data point in a matrix file. On input, index for within factor varies most rapidly. (For example, first record is subject one, treatment b_1 , subject one, treatment b_2 . . . , subject one, treatment b_k ; second record subject two, treatment b_1 , subject two, treatment b_2 . . . , subject two, treatment b_k . . . ; the last record is subject n , treatment b_1 , subject n , treatment b_2 . . . , subject n , treatment b_k .) A printout of the raw data file would show k data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of subjects (maximum 32767)
 - b. number of groups (maximum 100)
 - c. number of subjects in each group (maximum 32767)
 - d. name of file
 - e. format of data file
5. Printout gives:
 - a. raw data by group (optional)
 - b. for each group: N , Σx , Σx^2 , $\bar{X}$, and SD (unbiased estimate)
 - c. ANOVA source table

Comments:

The F-test is analogous to a t-test for correlated data when the design consists of only two treatment levels. This ANOVA design permits an experimenter to minimize the effects of individual differences. However, the design requires that the population covariances for all pairs of treatment levels be homogeneous.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 132-134.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for the Social Sciences.

RU,AV11
AV11 OR RBK
*** ONE WAY ANOVA FOR REPEATED MEASURES ***
NOTE: DATA INPUT READ SEQUENCE, INDEX FOR WITHIN
FACTOR VARIES MOST RAPIDLY. PROGRAM EXPECTS ALL
DATA TO BE IN ONE MATRIX FILE.
NOTE: MAXIMUM OF 100 TREATMENTS (WITHIN FACTOR)
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO
1
ENTER # SS/GP
8
ENTER # LEVELS FOR TREATMENTS:
4
ENTER NAME OF DATA FILE:
#AV11

ENTER FORMAT OF DATA:
(4(4X,F10.4))
:

RAW DATA

2.0000	7.0000	4.0000	7.0000
6.0000	8.0000	5.0000	8.0000
3.0000	7.0000	4.0000	9.0000
3.0000	6.0000	3.0000	8.0000
1.0000	5.0000	2.0000	10.0000
2.0000	6.0000	3.0000	10.0000
2.0000	5.0000	4.0000	9.0000
2.0000	6.0000	3.0000	11.0000

TREATMENT	N	SUMX	SUMX2	MEAN	SD
1	8	22.000	76.000	2.750	1.488
2	8	50.000	320.000	6.250	1.035
3	8	28.000	104.000	3.500	.926
4	8	72.000	660.000	9.000	1.309

SOURCE	SS	DF	MS	F	P
TOTAL	235.50000	31.			
TREATMENT	194.5000	3.	64.8333	47.7719	.00000
SUBJECTS	12.5000	7.	1.7857	1.3158	.29097
RESIDUAL	28.5000	21.	1.3571		

*AV11 T=00003 IS ON CR00002 USING 00014 BLKS R=0000

```

0001 FTH4,L
0002 PROGRAM AV11
0003 DIMENSION IFMT(20),INFILE(3)
0004 DOUBLE PRECISION S2(80),DMTX(80),XS2(80),S3,S4,S8,CT,SST
0005 DOUBLE PRECISION S8S,S11,S3TR,S8ER,XBAR(80),SD(80)
0006 DOUBLE PRECISION RMSS,RMSTR,RMSER,FS,FTR,TEMP
0007 DOUBLE PRECISION DFT,DFS,DFTR,DFER,DF1,DF2,F,Z,PS
0008 DIMENSION IB(272),IBUF(256)
0009 WRITE(1,4400)
0010 4400 FORMAT ( "AV11 OR RBK" ,/,
0011 C" *** ONE WAY ANOVA FOR REPEATED MEASURES ***" ,/,
0012 C" NOTE: DATA INPUT READ SEQUENCE, INDEX FOR WITHIN",/,
0013 C" FACTOR VARIES MOST RAPIDLY. PROGRAM EXPECTS ALL",/,
0014 C" DATA TO BE IN ONE MATRIX FILE." ,/,
0015 C" NOTE: MAXIMUM OF 80 TREATMENTS WITHIN FACTOR " ,/,
0016 C"ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: ")
0017 READ(1,*) IUNIT
0018 WRITE(1,4409)
0019 4409 FORMAT("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO ")
0020 READ(1,*) IPTO
0021 WRITE(1,4410)
0022 4410 FORMAT ( "ENTER # SUBJECTS/GROUP ")
0023 READ(1,*) NS
0024 WRITE(1,4411)
0025 4411 FORMAT ( "ENTER # LEVELS FOR TREATMENTS: ")
0026 READ(1,*) NLU
0027 WRITE(1,4412)
0028 4412 FORMAT ( "ENTER NAME OF DATA FILE: " )
0029 READ(1,106)INFILE
0030 106 FORMAT(3A2)
0031 IDCBS=256
0032 CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
0033 IF(IER.GE.0)GO TO 101
0034 WRITE(1,4413) INFILE,IER
0035 4413 FORMAT(5X,3A2,5X,"DATA FILE FAILED TO OPEN, IER = ",I5 )
0036 STOP 4413
0037 101 WRITE(1,4414)
0038 4414 FORMAT ( "ENTER FORMAT OF DATA: I.E. (4F10.4) ")
0039 READ(1,102)IFMT
0040 102 FORMAT(20A2)
0041 IF(IPTO.EQ.1)WRITE(IUNIT,1)
0042 1 FORMAT(" RAW DATA")
0043 DO 20 K=1,NS
0044 CALL READF(IB,IER,IBUF,IDCBS)
0045 CALL CODE

```

```

0046      READ(IBUF,IFMT)(DMTX(J),J=1,NLU)
0047      IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)(DMTX(J),J=1,NLU)
0048      TEMP=0
0049      DO 10 I=1,NLU
0050      NM=NM+1
0051      S2(I)=S2(I)+DMTX(I)
0052      XS2(I)=XS2(I)+DMTX(I)**2
0053      S3=S3+DMTX(I)**2
0054      S4=S4+DMTX(I)
0055      TEMP=TEMP+DMTX(I)
0056 10     CONTINUE
0057      S8=S8+TEMP**2
0058 20     CONTINUE
0059      CT=S4**2/NM
0060      SST=S3-CT
0061      SSS=(S8/NLU)-CT
0062      DO 30 I=1,NLU
0063      XBAR(I)=S2(I)/NS
0064 30     S11=S11+S2(I)**2
0065      S11=S11/NS
0066      SSTR=S11-CT
0067      SSER=SST-SSS-SSTR
0068      DFT=NM-1
0069      DFS=NS-1
0070      DFTR=NLU-1
0071      DFER=DFT-DFS-DFTR
0072      RMSS=SSS/DFS
0073      RMSTR=SSTR/DFTR
0074      RMSE=SSER/DFER
0075      FS=RMSS/RMSE
0076      FTR=RMSTR/RMSE
0077      DF1=DFS
0078      DF2=DFER
0079      F=FS
0080      CALL FPROB(F,DF1,DF2,Z,PS)
0081      DF1=DFTR
0082      DF2=DFER
0083      F=FTR
0084      CALL FPROB(F,DF1,DF2,Z,PTR)
0085      DO 50 I=1,NLU
0086      ANS=NS
0087 50     SD(I)=DSQRT((ANS*XS2(I)-(S2(I)**2))/(ANS*(ANS-1)))
0088      WRITE(IUNIT,51)(I,NS,S2(I),XS2(I),XBAR(I),SD(I),I=1,NLU)
0089 51     FORMAT(//," TREATMENT          N          SUMX          SUMX2
0090      $ MEAN          SD",//,
0091      $(I7,8X,I3,4X,F10.3,2X,F10.3,2X,F10.3,2X,F10.3))
0092      WRITE(IUNIT,105)SST,DFT,SSTR,DFTR,RMSTR,FTR,PTR,SSS,DFS,RMSS,
0093      $FS,PS,SSER,DFER,RMSE
0094 105    FORMAT(///,15X,"SOURCE TABLE ",///,X,"SOURCE ",12X,"SS",9X,
0095      $"DF",11X,"NS",11X,"F",10X,"P",///," TOTAL",9X,F12.4,1X,F6.0,
0096      $//," TREATMENT          ",2X,F12.4,1X,F6.0,3X,F12.4,3X,F10.4,3X,
0097      $F6.5,///," SUBJECTS          ",4X,F12.4,1X,F6.0,3X,F12.4,3X,F10.4,3X,
0098      $F6.5,///," RESIDUAL          ",4X,F12.4,1X,F6.0,3X,F12.4)
0099      CALL CLOSE(IB)
0100      END
0101      END$

```

AV20 (CRF-P,Q) (Two-way ANOVA)

Purpose:

This program performs a two-way completely randomized facotrial analysis of variance without replication.

Mathematical Model:

The model for this design is:

$$X_{ijm} = u + A_i + B_j + AB_{ij} + E_m(ij)$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $AB_{ij} = 0$ for all ij

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A ₁		A ₂		A ₃	
B ₁	B ₂	B ₁	B ₂	B ₁	B ₂
S ₁	S ₂	S ₃	S ₄	S ₅	S ₆

S represents a set of subjects

1. There are two factors (A,B) with p and q levels of treatments respectively. The experiment consists of pq treatment combinations. The above example includes three levels of Factor A, two levels of Factor B.
2. Subjects are randomly assigned to the pq treatment combinations, with each subject receiving only one combination.
3. There should be more than one subject per pq treatment combinations.

User Considerations and Procedures:

1. A data file must be created with each data point in a sequential file. On input, Factor B varies most rapidly, then Factor A. (For example, first record is subject one for treatment ab_{11} , second record subject two, treatment ab_{11} . . ., then subject one treatment ab_{12} , next is subject two, ab_{12} . . ., then subject one treatment ab_{21} . . ., final record would be subject n for treatment ab_{pq} .) A printout of the raw data file would show one data point per line.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of raw data can be obtained. Option: 1 if a raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of levels of Factor A (maximum 30)
 - b. number of levels of Factor B (maximum 30)
 - c. number of subjects per AB cell (maximum 32767)
 - d. name of data file
 - e. format of data file
5. Printout gives:
 - a. raw data (option)
 - b. for each cell: Σ , Σx^2 , $\bar{X}$, SD (unbiased estimate)
 - c. ANOVA source table

Comments:

Program uses least square analysis for unequal cell sample sizes. This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 175-176.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

RU,AV20
 AV20 OR CRFPQ
 REF: BRUNING & KINTZ, 1968
 SECTION 2.2
 FACTORIAL DESIGN: TWO FACTORS
 NOTE: PROGRAM CALCULATES LEAST SQUARES
 SOLUTION IF UNEQUAL CELL N'S
 NOTE: ON INPUT DATA READ SEQUENCE, INDEX
 FOR FACTOR B VARIES MOST
 RAPIDLY. PROGRAM EXPECTS DATA TO BE IN
 ONE SEQUENTIAL FILE.
 NOTE: MAX 30 * 30 DESIGN
 ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
 6
 DO YOU WANT TO PRINT OUT OF RAW DATA 1 = YES , 0 = NO
 1
 ENTER INPUT DATA FILE NAME:
 #AV20

ENTER INPUT DATA FORMAT:
 (4X,F10.4)
 ENTER # LEVELS ON FACTOR A & B:

2,4
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 1
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 2
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 3
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 4
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 2
 FACTOR B, LEVEL: 1
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 2
 FACTOR B, LEVEL: 2
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 2
 FACTOR B, LEVEL: 3
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 2
 FACTOR B, LEVEL: 4
 ENTER # SS THIS CELL:
 4
 :

GROUP	1 1	RAW DATA
	3.0000	
	6.0000	
	3.0000	
	3.0000	
GROUP	1 2	RAW DATA
	4.0000	
	5.0000	
	4.0000	
	3.0000	
GROUP	1 3	RAW DATA
	7.0000	
	8.0000	
	7.0000	
	6.0000	
GROUP	1 4	RAW DATA
	7.0000	
	8.0000	
	9.0000	
	8.0000	
GROUP	2 1	RAW DATA
	1.0000	
	2.0000	
	2.0000	
	2.0000	
GROUP	2 2	RAW DATA
	2.0000	
	3.0000	
	4.0000	
	3.0000	
GROUP	2 3	RAW DATA
	5.0000	
	6.0000	
	5.0000	
	6.0000	
GROUP	2 4	RAW DATA
	10.0000	
	9.0000	
	11.0000	
	10.0000	

CELL	N	SUMX	SUMX2	MEAN	SD
1 1	4	15.000	63.000	3.750	1.500
1 2	4	16.000	66.000	4.000	.816
1 3	4	28.000	198.000	7.000	.816
1 4	4	32.000	258.000	8.000	.816
2 1	4	7.000	13.000	1.750	.500
2 2	4	12.000	38.000	3.000	.816
2 3	4	22.000	122.000	5.500	.577
2 4	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
FACTOR A	3.125	1.	3.125	4.054	.052693
FACTOR B	194.500	3.	64.833	84.108	.000000
A * B	19.375	3.	6.458	8.378	.000788
ERROR	18.500	24.	.771		

*AV20 T=00003 IS ON CR00002 USING 00018 BLKS R=0000

```

0001 FTH4,L
0002     PROGRAM AV20
0003     DOUBLE PRECISION SX2(20,20),S2(20,20),S6(20),S7(20),RDATA
0004     DOUBLE PRECISION S3,S4,CT,SST,SSA,SSB,PAB,PB
0005     DOUBLE PRECISION SSAB,SSER,MSB,MSA,MSAB,MSER,FA,FB,FAB
0006     DOUBLE PRECISION TSS,XBAR,DFT,DFA,DFB,DFAB,DFER,F,DF1,DF2,Z,PA
0007     DIMENSION IB(272),IBUF(256)
0008     DIMENSION NS(20,20),IFMT(20),NS6(20),NS7(20)
0009     DIMENSION INFILE(3)
0010     WRITE(1,4400)
0011 4400  FORMAT ( "AV20 OR CRFPQ&" ,/,
0012           C "REF: BRUNING & KINTZ, 1968" ,/,
0013           C "SECTION 2.2" ,/,
0014           C "FACTORIAL DESIGN: TWO FACTORS" ,/,
0015           C "      NOTE: PROGRAM CALCULATES LEAST SQUARES" ,/,
0016           C "      SOLUTION IF UNEQUAL CELL N'S" ,)
0017     WRITE(1,4401)
0018 4401  FORMAT("      NOTE: ON INPUT DATA READ SEQUENCE, INDEX" ,/,
0019           C "      FOR FACTOR B VARIES MOST" ,/,
0020           C "      RAPIDLY. PROGRAM EXPECTS DATA TO BE IN" ,/,
0021           C "      ONE SEQUENTIAL FILE." ,/,
0022           C "      NOTE: MAX 20 * 20 DESIGN" ,//)
0023 290  WRITE(1,4411)
0024 4411  FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: " )
0025     READ(1,*) IUNIT
0026     IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 290
0027     WRITE(1,4412)
0028 4412  FORMAT("DO YOU WANT TO PRINT OUT OF RAW DATA I= YES , 0= NO")
0029     READ(1,*) IPTO
0030     WRITE(1,4413)
0031 4413  FORMAT ( "ENTER INPUT DATA FILE NAME: " )
0032     READ(1,194)INFILE
0033 194  FORMAT(3A2)
0034 191  FORMAT(20A2)
0035     IDCBS=256
0036     IF(LENGTH.LT.144) IDCBS=144
0037     CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
0038     IF(IER.GE.0)GO TO 19155
0039     WRITE(1,4414) IER
0040 4414  FORMAT ( "NO OPEN INPUT DATA FILE, IER = "15 )
0041     STOP
0042 19155 WRITE(1,4415)
0043 4415  FORMAT ( "ENTER INPUT DATA FORMAT: I.E. (F10.4)" )
0044     READ(1,191)IFMT
0045     WRITE(1,4416)
0046 4416  FORMAT ( "ENTER # LEVELS ON FACTOR A & B: " )
0047     READ(1,*) NLA,NLB
0048     HGPS=NLA*NLB
0049     DO 1915 LA=1,NLA
0050     DO 1915 LB=1,NLB
0051     WRITE(1,4417) LA

```

```

0052 4417 FORMAT ( "FACTOR A, LEVEL: ", IS )
0053 WRITE(1,4418) LB
0054 4418 FORMAT ( "FACTOR B, LEVEL: ", IS )
0055 WRITE(1,4419)
0056 4419 FORMAT ( "ENTER # SUBJECTS THIS CELL: " )
0057 READ(1,*) NS(LA, LB)
0058 K=NS(LA, LB)
0059 TSS=TSS+K
0060 IF(IPTO.EQ.1)WRITE(IUNIT,2)LA, LB
0061 2 FORMAT(" GROUP ", 2I3, " RAW DATA")
0062 DO 1914 M=1, K
0063 CALL READF(IB, IER, IBUF)
0064 CALL CODE
0065 READ(IBUF, IFMT)RDATA
0066 IF(IPTO.EQ.1)WRITE(IUNIT, IFMT)RDATA
0067 S2(LA, LB)=S2(LA, LB)+RDATA
0068 S3=S3+RDATA**2
0069 S4=S4+RDATA
0070 S6(LA)=S6(LA)+RDATA
0071 S7(LB)=S7(LB)+RDATA
0072 NS6(LA)=NS6(LA)+1
0073 NS7(LB)=NS7(LB)+1
0074 SX2(LA, LB)=SX2(LA, LB)+RDATA**2
0075 1914 CONTINUE
0076 1915 CONTINUE
0077 WRITE(IUNIT, 3004)
0078 DO 3005 I1=1, NLA
0079 DO 3005 I2=1, NLB
0080 XBAR=S2(I1, I2)/NS(I1, I2)
0081 ANS=NS(I1, I2)
0082 SD=DSQRT((ANS*SX2(I1, I2)-S2(I1, I2)**2)/
0083 *(ANS*(ANS-1.)))
0084 3005 WRITE(IUNIT, 301) I1, I2, NS(I1, I2), S2(I1, I2), SX2(I1, I2), XBAR, SD
0085 3004 FORMAT("0 CELL N SUMX SUMX2 MEAN"
0086 *, " SD")
0087 301 FORMAT(2X, 2I3, 3X, I4, 3X, 4(1X, F10.3))
0088 CT=S4**2/TSS
0089 SST=S3-CT
0090 DO 699 LA=1, NLA
0091 699 SSA=SSA+S6(LA)**2/NS6(LA)
0092 SSA=SSA-CT
0093 DO 799 LB=1, NLB
0094 799 SS8=SS8+S7(LB)**2/NS7(LB)
0095 SS8=SS8-CT
0096 DO 899 LA=1, NLA
0097 DO 899 LB=1, NLB
0098 899 SSAB=SSAB+S2(LA, LB)**2/NS(LA, LB)
0099 SSAB=SSAB-SSA SS8-CT
0100 SSER=SST-SSA-SS8-SSAB
0101 DFT=TSS-1
0102 DFA=NLA-1
0103 DFB=NLB-1
0104 DFAB=DFA*DFB
0105 DFER=DFT-DFA-DFB-DFAB
0106 MSA=SSA/DFA
0107 MSB=SS8/DFB
0108 MSAB=SSAB/DFAB
0109 MSER=SSER/DFER

```

```

0110      FA=MSA/MSER
0111      FB=MSB/MSER
0112      FAB=MSAB/MSER
0113      F=FA
0114      DF1=DFA
0115      DF2=DFER
0116      CALL FPROB(F,DF1,DF2,Z,PA)
0117      F=FB
0118      DF1=DFB
0119      DF2=DFER
0120      CALL FPROB(F,DF1,DF2,Z,PB)
0121      F=FAB
0122      DF1=DFAB
0123      DF2=DFER
0124      CALL FPROB(F,DF1,DF2,Z,PAB)
0125      WRITE(IUNIT,1299)SST,DFT,SSA,DFA,MSA,FA,PA,SSB,DFB,MSB,FB,PB,
0126      *SSAB,DFAB,MSAB,FAB,PAB,SSER,DFER,MSER
0127 1299  FORMAT("0  SOURCE",8X,"SS",5X,"DF",6X,"MS",9X,"F",11X,"P"//
0128      $" TOTAL",6X,F10.3,F5.0/3X,"FACTOR A ",F10.3,F5.0,2F10.3,F10.6/
0129      $3X,"FACTOR B ",F10.3,F5.0,2F10.3,F10.6/3X,"A * B",4X,F10.3,
0130      $F5.0,2F10.3,F10.6,/5X,"ERROR ",F10.3,F5.0,F10.3)
0131      CALL CLOSE(18,IER)
0132      END
0133      END$

```

AV21B (SPF-P.Q) (Two-way Split Plot ANOVA, Repeated Measures)

Purpose:

This program performs a two-way split-plot or mixed analysis of variance.

Mathematical Model:

The model for this design is:

$$X_{ijm} = \mu + A_i + B_j + AB_{ij} + \pi_m(i) + B\pi_{jm(i)} + E_{o(ijm)}$$

The hypotheses to be tested are:

$$H_0: A_i = 0 \text{ for all } i$$

$$H_0: B_j = 0 \text{ for all } j$$

$$H_0: AB_{ij} = 0 \text{ for all } ij$$

The mixed effect model (Model III) was used in the derivation of the expected values of the mean squares.

Layout of Design:

	B ₁	B ₂	B ₃
A ₁	S ₁	S ₁	S ₁
A ₂	S ₂	S ₂	S ₂

S represents a set of subjects

1. There are two Factors (A and B) with p, q levels of treatments respectively. Factor A is designated as the between block or nonrepeated measure. Factor B is the within block repeated measure. The above example includes two levels of Factor A, three levels of Factor B.
2. Subjects from a common population are randomly assigned to the levels of Factor A. After this, levels of treatment B are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.

User Considerations and Procedures:

1. A matrix data file must be created with all data points for each subject in one record. On read input, the within Factor B varies fastest, then Factor A. (For example, record one contains subject 1, cell ab_{11} , ab_{12} . . . , ab_{1q} ; second record is subject 2, ab_{11} , ab_{12} . . . , ab_{1q} ; etc. Repeat the same procedure for subjects in Factor A_p.) A printout of the raw data would show q data points per line.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of levels of between Factor A (maximum 25)
 - b. number of levels of within Factor B (maximum 25)
 - c. number of subjects per AB cell (maximum 32767)
 - d. name of data file
 - e. format of data file
5. Printout gives:
 - a. raw data by group (optional)
 - b. for each group: N , Σx , Σx^2 , $\bar{X}$, and SD (unbiased estimate)
 - c. ANOVA source table

Comments:

Program uses least squares analysis for unequal cell sizes on Factor A. This ANOVA design permits interaction effects to be evaluated. In a split-plot design, estimates of the within block (Factor B and interaction AB) effects are more accurate than estimates of between block (Factor A) effects. If an experimenter's primary interest is in the within-block effects, a split-plot design is more powerful than a randomized factorial block design (AV22). However, if equal precision for all treatment effects is desired, the average power of a randomized factorial block design is greater. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 249-251.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

RU,AV21B
AV21B OR SPFPQ
REF: BRUNING & KINTZ, 1968
SECTION 2.7
TWO FACTOR MIXED DESIGN: REPEATED MEASURES ON ONE FACTOR
NOTE: PROGRAM CALCULATES LEAST SQUARES SOLUTION
IF UNEQUAL CELL N'S
NOTE: ON INPUT DATA READ SEQUENCE, INDEX FOR
WITHIN FACTOR (B) VARIES MOST RAPIDLY.
PROGRAM EXPECTS ALL DATA TO BE IN
ONE MATRIX FILE.
NOTE: MAX 25B * 25W DESIGN
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:
6
DO YOU WANT TO PRINT OUT DATA 1 = YES , 0 = NO
1
ENTER INPUT DATA FILE NAME:
#AV11

ENTER INPUT DATA FORMAT:
(4(4X,F10.4))
ENTER # LEVELS FOR BETWEEN FACTOR (MAX 25):
2
ENTER # LEVELS FOR WITHIN FACTOR (MAX 25):
4
GROUP NUMBER: 1
ENTER NUMBER OF SUBJECTS IN THIS GROUP:
4
GROUP NUMBER: 2
ENTER NUMBER OF SUBJECTS IN THIS GROUP:
4
:

GROUP: 1 RAW DATA

3.000	7.000	4.000	7.000
6.000	8.000	5.000	8.000
3.000	7.000	4.000	9.000
3.000	6.000	3.000	8.000

GROUP: 2 RAW DATA

1.000	5.000	2.000	10.000
2.000	6.000	3.000	10.000
2.000	5.000	4.000	9.000
2.000	6.000	3.000	11.000

CELL	N	SUMX	SUMX2	MEAN	STD DEV
1 1	4	15.000	63.000	3.750	1.500
1 2	4	28.000	198.000	7.000	.816
1 3	4	16.000	66.000	4.000	.816
1 4	4	32.000	258.000	8.000	.816
2 1	4	7.000	13.000	1.750	.500
2 2	4	22.000	122.000	5.500	.577
2 3	4	12.000	38.000	3.000	.816
2 4	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
BETWEEN	12.500	7.			
FACTOR A	3.125	1.	3.125	2.000	.205762
ERROR BTW	9.375	6.	1.562		
WITHIN	223.000	24.			
FACTOR B	194.500	3.	64.833	127.890	.000000
A * B	19.375	3.	6.458	12.740	.000228
ERROR W/IN	9.125	18.	.507		

*AV21B T=00004 IS ON CR00002 USING 00023 BLKS R=0192

```

0001 FTH4,L
0002 PROGRAM AV21B
0003 DOUBLE PRECISION DVECTR(20),SASX(20),SASX2(20),SS(20)
0004 DOUBLE PRECISION MSC,MSERRB,MSTR,MSTRXC,FC,FTR,2,PC,PTR,PTRXC
0005 DOUBLE PRECISION DSX(20,20),DSX2(20,20),GSX2(20),GSX(20)
0006 DOUBLE PRECISION TEMP,TSX2,CT,SST,SSC,SSB,SSW,FTRXC,F,DF1,DF2
0007 DOUBLE PRECISION MSERRW,GT,SSTRXC,SSTR,DFTRXC,DFSERW
0008 DOUBLE PRECISION SIG(20,20),SAXS2(20),XBAR(20,20),TNS,SSERRB
0009 DOUBLE PRECISION SSERRW,DFS8,DFST,DFSC,DFSERB,DFS8W,DFSTR
0010 DIMENSION IB(272),IBUF(256),IFILE(3),NSS(20),IFMT(20)
0011 WRITE(1,4400)
0012 4400 FORMAT ( "AV21B OR SPFPQ" ,/,
0013 C "REF: BRUNING & KINTZ, 1968" ,/,
0014 C "SECTION 2.7" ,/,
0015 C "TWO FACTOR MIXED DESIGN: REPEATED MEASURES ON ONE FACTOR",/,
0016 C " NOTE: PROGRAM CALCULATES LEAST SQUARES SOLUTION",/,
0017 C " IF UNEQUAL CELL N'S" )
0018 WRITE(1,4406)
0019 4406 FORMAT ( " NOTE: ON INPUT DATA READ SEQUENCE, INDEX FOR",/,
0020 C " WITHIN FACTOR (B) VARIES MOST RAPIDLY." ,/,
0021 C " PROGRAM EXPECTS ALL DATA TO BE IN" ,/,
0022 C " ONE MATRIX FILE." ,/,
0023 C " NOTE: MAX 20B * 20W DESIGN" )
0024 1 WRITE(1,4411)
0025 4411 FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT: " )
0026 READ(1,*) IUNIT
0027 IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 97
0028 WRITE(1,4412)
0029 4412 FORMAT ( "DO YOU WANT TO PRINT OUT DATA 1 = YES , 0 = NO " )
0030 READ(1,*) IPTO
0031 WRITE(1,4413)
0032 4413 FORMAT ( "ENTER INPUT DATA FILE NAME:" )
0033 READ(1,85)IFILE
0034 85 FORMAT(3A2)
0035 IDCBS=256
0036 CALL OPEN(1B,IER,IFILE,3,0,-2,IDCBS)
0037 IF(IER.LT.0)GO TO 98
0038 WRITE(1,4414)
0039 4414 FORMAT ( "ENTER INPUT DATA FORMAT I.E. (4F10.4)" )
0040 READ(1,80)IFMT
0041 80 FORMAT(20A2)
0042 WRITE(1,4415)
0043 4415 FORMAT ( "ENTER # LEVELS FOR BETWEEN FACTOR (MAX 20): " )
0044 READ(1,*) NGPS
0045 WRITE(1,4416)
0046 4416 FORMAT ( "ENTER # LEVELS FOR WITHIN FACTOR (MAX 20): " )
0047 READ(1,*) NLW
0048 DO 19 NG=1,NGPS
0049 WRITE(1,4417) NG
0050 4417 FORMAT ( "GROUP NUMBER: ",15 )
0051 WRITE(1,4418)
0052 4418 FORMAT ( "ENTER NUMBER OF SUBJECTS IN THIS GROUP: " )
0053 READ(1,*) ISS

```

```

0054      TMS=TMS+ISS
0055      NSS(NC)=ISS
0056      IF(IPTO.EQ.1)WRITE(IUNIT,2)NC
0057 2      FORMAT(" GROUP: ",I3," RAW DATA")
0058      DO 10 J2=1,ISS
0059      CALL READF(IB,IER,IBUF)
0060      CALL CODE
0061      READ(IBUF,IFMT)(DVECTR(J1),J1=1,NLW)
0062      TEMP=0.
0063      IF(IPTO.EQ.1)WRITE(IUNIT,9)(DVECTR(J3),J3=1,NLW)
0064 9      FORMAT(10F9.3)
0065      DO 7 J1=1,NLW
0066      TEMP=TEMP+DVECTR(J1)
0067      SASX(NC)=SASX(NC)+DVECTR(J1)
0068      SASX2(NC)=SASX2(NC)+DVECTR(J1)**2
0069      DSX(NC,J1)=DSX(NC,J1)+DVECTR(J1)
0070      DSX2(NC,J1)=DSX2(NC,J1)+DVECTR(J1)**2
0071 7      CONTINUE
0072      SAXS2(NC)=SAXS2(NC)+TEMP**2
0073 10     CONTINUE
0074      SS(NC)=NSS(NC)
0075      DO 11 J1=1,NLW
0076      XBAR(NC,J1)=DSX(NC,J1)/SS(NC)
0077      SIG(NC,J1)=DSQRT((SS(NC)+DSX2(NC,J1)-DSX(NC,J1)**2)/
0078      *(SS(NC)*(SS(NC)-1)))
0079      GSX(NC)=GSX(NC)+DSX(NC,J1)
0080      GSX2(NC)=GSX2(NC)+DSX2(NC,J1)
0081 11     CONTINUE
0082 19     CONTINUE
0083      WRITE(IUNIT,1904)
0084 1904   FORMAT(/" CELL      N      SUMX      SUMX2      MEAN      ",
0085      C"STD DEV")
0086      DO 191 J1=1,NGPS
0087 1905   FORMAT(2I3,16,4F10.3)
0088      WRITE(IUNIT,1905)(J1,J5,NSS(J1),DSX(J1,J5),DSX2(J1,J5),
0089      *XBAR(J1,J5),SIG(J1,J5),J5=1,NLW)
0090 191     CONTINUE
0091      DO 1915 J1=1,NGPS
0092      TSX2=TSX2+GSX2(J1)
0093 1915   GT=GT+GSX(J1)
0094      CT=GT**2/(TMS*NLW)
0095      SST=TSX2-CT
0096      DO 1916 J1=1,NGPS
0097      SSC=SSC+GSX(J1)**2/(SS(J1)*NLW)
0098 1916   SSB=SSB+SAXS2(J1)
0099      SSB=SSB/NLW-CT
0100      SSC=SSC-CT
0101      SSERRB=SSB-SSC
0102      SSW=SST-SSB
0103      TEMP=0
0104      DO 1976 J1=1,NLW
0105      DO 1975 K1=1,NGPS
0106      SSTRXC=SSTRXC+DSX(K1,J1)**2/SS(K1)
0107 1975   TEMP=TEMP+DSX(K1,J1)
0108      TEMP=TEMP**2/TMS
0109      SSTR=SSTR+TEMP
0110 1976   TEMP=0.

```

```

0111      SSTR=SSTR-CT
0112      SSTRXC=SSTRXC-SSC-SSTR-CT
0113      SSERRW=SSW-SSTR-SSTRXC
0114      DO 199 J1=1,NGPS
0115      DFB=DFB+SS(J1)
0116 199   DFST=DFST+SS(J1)
0117      DFST=DFST-HLW-1
0118      DFB=DFB-1
0119      DFSC=NGPS-1
0120      DFSEB=DFB-DFSC
0121      DFSW=DFST-DFB
0122      DFSTR=HLW-1
0123      DFTRXC=DFSTR*DFSC
0124      DSFERW=FSW-DFSTR-DFTRXC
0125      MSC=SSC/DFSC
0126      MSERRB=SSERRB/DFSEB
0127      MSTR=SSTR/DFSTR
0128      MSTRXC=SSTRXC/DFTRXC
0129      MSERRW=SSERRW/DSFERW
0130      FC=MSC/MSERRB
0131      FTR=MSTR/MSERRW
0132      FTRXC=MSTRXC/MSERRW
0133      F=FC
0134      DF1=DFSC
0135      DF2=DFSEB
0136      CALL FPROB(F,DF1,DF2,Z,PC)
0137      F=FTR
0138      DF1=DFSTR
0139      DF2=DSFERW
0140      CALL FPROB(F,DF1,DF2,Z,PTR)
0141      F=FTRXC
0142      DF1=DFTRXC
0143      DF2=DSFERW
0144      CALL FPROB(F,DF1,DF2,Z,PTRXC)
0145 20     FORMAT('0      SOURCE      SS      DF      MS      F      ',
0146      C'      P',/' TOTAL',
0147      $9X,F10.3,F5.0/' BETWEEN      ',F10.3,F5.0/' FACTOR A  '
0148      $,F10.3,F5.0,2F10.3,F10.6/' ERROR BTW ',F10.3,F5.0,F10.3/'
0149      $' WITHIN',6X,F10.3,F5.0/5X,'FACTOR B  ',F10.3,F5.0,2F10.3,
0150      $F10.6,/,5X,'A * B',5X,F10.3,F5.0,2F10.3,F10.6/5X,'ERROR W/IN',
0151      $F10.3,F5.0,F10.3)
0152      WRITE(IUNIT,20)SST,DFST,SSB,DFB,SSC,DFSC,MSC,FC,PC,SSERRB,
0153      $DFSEB,
0154      $MSERRB,SSW,FSW,SSTR,DFSTR,MSTR,FTR,PTR,SSTRXC,DFTRXC,MSTRXC,
0155      $FTRXC,PTRXC,SSERRW,DSFERW,MSERRW
0156      CALL CLOSE(IB,IER)
0157      GO TO 834
0158 98     WRITE(1,4420) IER
0159 4420   FORMAT ( 'INPUT DATA FILE FAILED TO OPEN, ERROR CODE: ',I5 )
0160      STOP
0161 97     WRITE(1,4421)
0162 4421   FORMAT ( 'INVALID OUTPUT UNIT #' )
0163      GO TO 1
0164 834    EN?
0165      ENDS

```

AV22 (RBF-P,Q) (Two-way ANOVA, Repeated Measures)

Purpose:

This program performs a two-way randomized block factorial analysis of variance with replication either by using matched subjects or repeated measures with one subject.

Mathematical Model:

The model for this design is:

$$X_{ijm} = \mu + A_i + B_j + AB_{ij} + \pi_m + E_{ijm}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $AB_{ij} = 0$ for all ij

The fixed effect model (Model 1) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A ₁		A ₂		A ₃	
B ₁	B ₂	B ₁	B ₂	B ₁	B ₂
S ₁	S ₁	S ₁	S ₁	S ₁	S ₁

S represents a set of subjects

1. There are two Factors (A,B) with p and q levels of treatments respectively. The experiment consists of pq treatment combinations. The above example includes three levels of Factor A, two levels of Factor B.
2. Subjects are randomly assigned to the pq treatment combinations with each subject or a set of matched subjects receiving all combinations. The order of administration of the pq combinations is randomized independently for each subject. If sets of matched subjects are used, one subject from each set is randomly assigned to each treatment combination.
3. There should be more than one subject per pq treatment combinations.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, Factor B varies most rapidly; then Factor A, then subjects. (For example, record one contains subject one, treatments ab_{11} , $ab_{12} \dots$, ab_{1q} ; record two, subject one, treatment ab_{21} , $ab_{22} \dots$, ab_{2q} . . . , subject one, treatment ab_{p1} , $ab_{p2} \dots$, ab_{pq} ; next record, subject two, treatments ab_{11} , $ab_{12} \dots$, $ab_{1q} \dots$, subject n, treatments ab_{p1} , $ab_{p2} \dots$, ab_{pq} .) A printout of the raw data file would show q data points per line.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of levels of Factor A (maximum 25)
 - b. number of levels of Factor B (maximum 25)
 - c. number of subjects (maximum 1000)
 - d. name of data file
 - e. format of data file
5. Printout gives:
 - a. raw data by group (optional)
 - b. for each group: N , Σx , Σx^2 , $\bar{X}$, and SD (unbiased estimate)
 - c. ANOVA source table

Comments:

This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 238-240.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

RU,AV22
AV22 OR RBF-P,Q TWO WAY ANOVA WITH REPEATED MEASURES
OR BLOCKS ON BOTH FACTORS. INDEX FOR FACTOR B FIRST,
THEN A AND LAST SUBJECTS. PROGRAM EXPECTS Q POINTS PER LINE
ENTER DATA FILE NAME
#JRB PQ

ENTER FORMAT OF DATA
(4(2X,F8.4))
ENTER 1 FOR CRT, 6 FOR LINE PRINTER OUTPUT
6
LEVELS OF A
2
LEVELS OF B
4
HOW MANY SUBJECTS
4
PRINT OUT OF RAW DATA (1=YES,0=NO)
1
:

RAW DATA

3.0000	4.0000	7.0000	7.0000
1.0000	2.0000	5.0000	10.0000
6.0000	5.0000	8.0000	8.0000
2.0000	3.0000	6.0000	10.0000
3.0000	4.0000	7.0000	9.0000
2.0000	4.0000	5.0000	9.0000
3.0000	3.0000	6.0000	8.0000
2.0000	3.0000	6.0000	11.0000

CELL	N	SUMX	SUMX2	MEAN	SD
1 1	4	15.000	63.000	3.750	1.500
1 2	4	16.000	66.000	4.000	.816
1 3	4	28.000	198.000	7.000	.816
1 4	4	32.000	258.000	8.000	.816
2 1	4	7.000	13.000	1.750	.500
2 2	4	12.000	38.000	3.000	.816
2 3	4	22.000	122.000	5.500	.577
2 4	4	40.000	402.000	10.000	.816

SOURCE	SS	SOURCE TABLE		F	P(F)
		DF	MS		
A	3.125	1	3.125	4.953	.03516
B	194.500	3	64.833	102.755	.00000
AB	19.375	3	6.458	10.236	.00041
RESIDUAL	13.250	21.	.631		
TOTAL	235.500	31.			

"AV22 T=00003 IS ON CR00002 USING 00016 BLKS R=0000

```

0001 FTH4,L
0002 PROGRAM AV22
0003 DOUBLE PRECISION ABB(400),SSS(1000),AII(20),BJJ(20),BSS(20),PF3
0004 DOUBLE PRECISION X1(400),X2(400),XR(20),WC1,A1B1,AB2,AF2,BG2
0005 DOUBLE PRECISION X,SY, SX,SA,AS,BS,AF,AB,BG,WC,XN,XB,SD,DW,DI
0006 DOUBLE PRECISION AF3,BG3,AB3,A1,B1,DP,AF1,BG1,AB1,ZEE,PF1,PF2
0007 DIMENSION NFILE(3),IFMT(20),IB(272),IBUF(256)
0008 INTEGER A,B
0009 WRITE(1,4400)
0010 4400 FORMAT("AV22 OR RBF-P,Q TWO WAY ANOVA WITH REPEATED MEASURES"
0011 &,"/,10X,"OR BLOCKS ON BOTH FACTORS. INDEX FOR FACTOR B FIRST,"
0012 &,"/,10X," THEN A AND LAST SUBJECTS. PROGRAM EXPECTS Q POINTS "
0013 &,"PER LINE",/,
0014 C"ENTER DATA FILE NAME")
0015 READ(1,16)NFILE
0016 16 FORMAT(3A2)
0017 IDCBS=256
0018 CALL OPEN(1B,IER,NFILE,3,0,-2,IDCBS)
0019 IF(IER.LT.0)GO TO 999
0020 WRITE(1,4401)
0021 4401 FORMAT ( " ENTER FORMAT OF DATA " )
0022 READ(1,6)IFMT
0023 6 FORMAT(20A2)
0024 WRITE(1,145)
0025 145 FORMAT(" ENTER 1 FOR CRT, 6 FOR LINE PRINTER OUTPUT")
0026 READ(1,*) IUNIT
0027 WRITE(1,4402)
0028 4402 FORMAT ( " LEVELS OF A " )
0029 READ(1,*) A
0030 WRITE(1,4403)
0031 4403 FORMAT ( " LEVELS OF B " )
0032 READ(1,*) B
0033 WRITE(1,4404)
0034 4404 FORMAT ( " HOW MANY SUBJECTS " )
0035 READ(1,*) N
0036 WRITE(1,942)
0037 942 FORMAT("PRINT OUT OF RAW DATA (1=YES,0=NO)?")
0038 READ(1,*) IPT0
0039 DO 250 K=1,N
0040 DO 320 I=1,A
0041 CALL READF(1B,IER,IBUF)
0042 CALL CODE
0043 READ(1B,IFMT) (XR(KL),KL=1,B)
0044 IF(IPT0.EQ.1) WRITE(IUNIT,IFMT) (XR(J),J=1,B)
0045 DO 430 J=1,B
0046 X=XR(J)
0047 SY=SY+X*X
0048 II=(I-1)*B+J
0049 X1(II)=X1(II)+X
0050 X2(II)=X2(II)+X*X
0051 SX= SX+X

```

```

0052      II=I+A*(J-1)
0053      ABB(II)=ABB(II)+X
0054      SSS(K)=SSS(K)+X
0055      AII(I)=AII(I)+X
0056      BJJ(J)=BJJ(J)+X
0057      BSS(J)=BSS(J)+X
0058  430    SA=SA+X
0059      AS=AS+SA=SA/B
0060  320    SA=0
0061      DO 250 J=1,B
0062      BS=BS+BSS(J)*BSS(J)/A
0063  250    BSS(J)=0
0064      DO 230 I=1,A
0065      AF=AF+AII(I)*AII(I)/(B*N)
0066      DO 630 J=1,B
0067      II=I+A*(J-1)
0068      AB=AB+ABB(II)*ABB(II)/N
0069  630    CONTINUE
0070  230    CONTINUE
0071      DO 240 J=1,B
0072      BG=BG+BJJ(J)*BJJ(J)/(A*N)
0073  240    CONTINUE
0074      X=0
0075      DO 1450 I=1,N
0076  1450    X=X+SSS(I)*SSS(I)/(A*B)
0077      SX=SX*SX/(A*B*N)
0078      WC=SY+SX-X-AB
0079      SY=SY-SX
0080      AB=AB+SX-AF-BG
0081      AF=AF-SX
0082      BG=BG-SX
0083      WRITE(IUNIT,101)
0084  101     FORMAT(///,"0 CELL",6X,"N",10X,"SUMX",6X,"SUMX2",8X,
0085             1"MEAN",8X,"SD",/)
0086      XN=N
0087      DO 102 I=1,A
0088      DO 102 J=1,B
0089      II=(I-1)*B+J
0090      XB=X1(II)/XN
0091      SD=DSQRT((X2(II)-(X1(II)*X1(II))/XN)/(XN-1.))
0092  102     WRITE(IUNIT,127) I,J,N,X1(II),X2(II),XB,SD
0093  127     FORMAT(2I3,3X,14,3X,4(1X,F10.3))
0094      WRITE(IUNIT,810)
0095  810     FORMAT(///,15X,"SOURCE TABLE",//," SOURCE",9X,"SS",8X,"DF",
0096             110X,"MS",10X,"F",11X,"P(F)",/)
0097      DW=(A*B-1)*(N-1)
0098      A=A-1
0099      B=B-1
0100      DI=A*B
0101      WC1=WC
0102      A1B1=(A+1)*(B+1)*N-1
0103      WC=WC/DW

```

```

0104      AB2=AB/DI
0105      AF2=AF/A
0106      BG2=BG/B
0107      AF3=AF2/UC
0108      BG3=BG2/UC
0109      AB3=AB2/UC
0110      A1=A
0111      B1=B
0112      DP=DW
0113      AF1=AF3
0114      BG1=BG3
0115      AB1=AB3
0116      CALL FPROB(AF1,A1,DP,ZEE,PF1)
0117      DP=DW
0118      CALL FPROB(BG1,B1,DP,ZEE,PF2)
0119      DP=DW
0120      CALL FPROB(AB1,D1,DP,ZEE,PF3)
0121      WRITE(IUNIT,820) AF,A,AF2,AF3,PF1,BG,B,BG2,BG3,PF2,AB,D1,AB2,
0122      1AB3,PF3,UC1,DW,UC,SY,A1B1
0123      820      FORMAT(3X,"A",9X,F8.3,5X,I3,2(5X,F8.3),,5X,F8.5,/,
0124      13X,"B",9X,F8.3,5X,I3,2(5X,F8.3),5X,F8.5,/,
0125      22X,"AB",9X,F8.3,5X,I3,2(5X,F8.3),5X,F8.5,/,
0126      32X,"RESIDUAL",X,F10.3,X,F8.0,4X,F8.3,///," TOTAL",7X,F8.3,1X,
0127      4F8.0)
0128      CALL CLOSE(IB,IER)
0129      GO TO 987
0130      999      WRITE(1,4409)
0131      4409      FORMAT ( " ERROR ON CALL OPEN STATEMENT " )
0132      STOP
0133      987      END
0134      END#

```

AV30 (CRF - P,Q,R) (Three-way ANOVA)

Purpose:

This program performs a three-way completely randomized factorial analysis of variance without replication.

Mathematical Model:

The model for this design is:

$$X_{ijkm} = \mu + A_i + B_j + C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + E_m(ijk)$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $C_k = 0$ for all k

Ho: $AB_{ij} = 0$ for all ij

Ho: $AC_{ik} = 0$ for all ik

Ho: $BC_{jk} = 0$ for all jk

Ho: $ABC_{ijk} = 0$ for all ijk

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

	B ₁		B ₂	
	C ₁	C ₂	C ₁	C ₂
A ₁	S ₁	S ₂	S ₃	S ₄
A ₂	S ₅	S ₆	S ₇	S ₈

S represents a set of subjects

1. There are three Factors (A,B,C) with p , q , and r levels of treatments respectively. The experiment consists of pqr treatment combinations. The above example includes two levels of each of Factors A, B, and C.

2. Subjects are randomly assigned to the pqr treatment combinations with each subject receiving only one combination.
3. There should be more than one subject per pqr treatment combination.

User Considerations and Procedures:

1. A data file must be created with each point in a sequential file indexing for subjects within Factor C fastest, then Factor B, and finally A. (For example, first record is subject one for treatment abc₁₁₁, second record is subject two for treatment abc₁₁₁ . . . , then subject one for treatment abc₁₁₂, then subject two for treatment abc₁₁₂ . . . , last record would be subject n for treatment abc_{pqr}.) A printout of the raw data file would show one data point per line.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by above option (#2).
4. Parameters required:
 - a. number of levels of Factor A (maximum 9)
 - b. number of levels of Factor B (maximum 9)
 - c. number of levels of Factor C (maximum 9)
 - d. number of subjects per ABC cell (maximum 32767)
 - e. name of data file
 - f. format of data file
5. Printout gives:
 - a. raw data (optional)
 - b. for each cell (treatment combination): N, Σx , Σx^2 , $\bar{X}$, and SD (unbiased estimate)
 - c. ANOVA course table

Comments:

Program uses least square analysis for unequal cell sample sizes. This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 218-221.

The accuracy of this program is less than that obtained by the Statistical Analysis System and Statistical Package for Social Sciences. The data analysis output is only accurate to five digit places instead of ten digits.

RU,AV30
 AV30 OR CRFPQR
 REF: BRUNING & KINTZ, 1968
 SECTION 2.3
 FACTORIAL DESIGN: THREE FACTORS
 NOTE: ON INPUT DATA READ SEQUENCE, INDEX FOR
 FACTOR C WILL VARY MOST RAPIDLY, INDEX
 FOR FACTOR B VARIES NEXT, THEN INDEX
 FOR FACTOR A VARIES. PROGRAM EXPECTS
 ALL DATA TO BE IN ONE SEQUENTIAL FILE.
 NOTE: MAX 9 * 9 * 9 DESIGN
 ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
 6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO
 1
 ENTER NAME OF INPUT DATA FILE:
 #AV20

ENTER INPUT DATA FORMAT:
 (4x,F10.4)
 ENTER # LEVELS FACTORS A, B, & C:
 2,2,2
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 1
 FACTOR C, LEVEL: 1
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 1
 FACTOR C, LEVEL: 2
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 2
 FACTOR C, LEVEL: 1
 ENTER ## SS THIS CELL:
 4
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 2
 FACTOR C, LEVEL: 2
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 2
 FACTOR B, LEVEL: 1
 FACTOR C, LEVEL: 1
 ENTER # SS THIS CELL:
 4
 FACTOR A, LEVEL: 2
 FACTOR B, LEVEL: 1
 FACTOR C, LEVEL: 2
 ENTER # SS THIS CELL:
 4

FACTOR A, LEVEL: 2
FACTOR B, LEVEL: 2
FACTOR C, LEVEL: 1
ENTER # SS THIS CELL:

4

FACTOR A, LEVEL: 2
FACTOR B, LEVEL: 2
FACTOR C, LEVEL: 2
ENTER # SS THIS CELL:

4

:

LEVEL: 1 1 1 RAW DATA

3.0000
6.0000
3.0000
3.0000

LEVEL: 1 1 2 RAW DATA

4.0000
5.0000
4.0000
3.0000

LEVEL: 1 2 1 RAW DATA

7.0000
8.0000
7.0000
6.0000

LEVEL: 1 2 2 RAW DATA

7.0000
8.0000
9.0000
8.0000

LEVEL: 2 1 1 RAW DATA

1.0000
2.0000
2.0000
2.0000

LEVEL: 2 1 2 RAW DATA

2.0000
3.0000
4.0000
3.0000

LEVEL: 2 2 1 RAW DATA

5.0000
6.0000
5.0000
6.0000

LEVEL: 2 2 2 RAW DATA

10.0000
9.0000
11.0000
10.0000

CELL	N	SUMX	SUMX2	MEAN	SD
1 1 1	4	15.000	63.000	3.750	1.500
1 1 2	4	16.000	66.000	4.000	.816
1 2 1	4	28.000	198.000	7.000	.816
1 2 2	4	32.000	258.000	8.000	.816
2 1 1	4	7.000	13.000	1.750	.500
2 1 2	4	12.000	38.000	3.000	.816
2 2 1	4	22.000	122.000	5.500	.577
2 2 2	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
FACTOR A	3.125	1.	3.125	4.054	.052693
FACTOR B	162.000	1.	162.000	210.162	.000000
FACTOR C	24.500	1.	24.500	31.784	.000050
A * B	6.125	1.	6.125	7.946	.009279
A * C	10.125	1.	10.125	13.135	.001666
B * C	8.000	1.	8.000	10.378	.003874
A * B * C	3.125	1.	3.125	4.054	.052693
ERROR	18.500	24.	.771		

*AV30 T=00004 IS ON CR00002 USING 00027 BLKS R=0224

```

0001 FTH4,L
0002 PROGRAM AV30
0003 DOUBLE PRECISION MSA,MSB,MSC,MSAB,MSAC,MSBC,MSABC,MSER
0004 DOUBLE PRECISION FA,FB,FC,FAB,FAC,FBC,FABC,F,DF1,DF2,Z
0005 DOUBLE PRECISION PA,PB,PC,PAB,PAC,PBC,PABC
0006 DOUBLE PRECISION SX2(8,8,8),XBAR(8,8,8),SD(8,8,8)
0007 DOUBLE PRECISION S2(8,8,8),S6(8),S7(8),S8(8),S9(8,8),S10(8,8),
0008 $S11(8,8),RDATA,T98,S3,S4,CT,SST,SSA,SSB,SSC,SSAB,SSAC,SSBC,
0009 $SSABC,SSER,DFT,DFA,DFB,DFC,DFAB,DFAC,DFBC,DFABC,DFER
0010 DIMENSION IB(144),IBUF(128),IFMT(20),INFILE(3),NS(8,8,8)
0011 DIMENSION NS6(8),NS7(8),NS8(8),NS9(8,8),NS10(8,8),NS11(8,8)
0012 WRITE(1,4400)
0013 4400 FORMAT ( "AV30 OR CRFPQR" ,/,
0014 C "REF: BRUNING & KINTZ, 1968" ,/,
0015 C "SECTION 2.3" ,/,
0016 C "FACTORIAL DESIGN: THREE FACTORS" ,/,
0017 C " NOTE: ON INPUT DATA READ SEQUENCE, INDEX FOR" ,/,
0018 C " FACTOR C WILL VARY MOST RAPIDLY, INDEX" )
0019 WRITE(1,4406)
0020 4406 FORMAT ( " FOR FACTOR B VARIES NEXT, THEN INDEX" ,/,
0021 C " FOR FACTOR A VARIES. PROGRAM EXPECTS" ,/,
0022 C " ALL DATA TO BE IN ONE SEQUENTIAL FILE." ,/,
0023 C " NOTE: MAX 8 * 8 * 8 DESIGN" )
0024 4975 WRITE(1,4410)
0025 4410 FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: " )
0026 READ(1,*) IUNIT
0027 IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 4975
0028 WRITE(1,4411)
0029 4411 FORMAT ("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO ")
0030 READ(1,*) IPTO
0031 WRITE(1,4412)
0032 4412 FORMAT ( "ENTER NAME OF INPUT DATA FILE:" )
0033 READ(1,498)INFILE
0034 498 FORMAT(3A2)
0035 IDCBS=128
0036 CALL OPEN (IB,IER,INFILE,3,0,-2,IDCBS)
0037 IF(IER.GE.0)GO TO 4985
0038 WRITE(1,4413) INFILE,IER
0039 4413 FORMAT(5X,3A2,4X,"NO OPEN INPUT DATA FILE, IER = ",I5 )
0040 STOP 4413
0041 4985 WRITE(1,4414)
0042 4414 FORMAT ( "ENTER INPUT DATA FORMAT:" )
0043 READ(1,477)IFMT
0044 477 FORMAT(20A2)
0045 WRITE(1,4415)
0046 4415 FORMAT ( "&ENTER # LEVELS FACTORS A, B, & C: ")
0047 READ(1,*) NLA,NLB,NLC
0048 DO 500 LA=1,NLA
0049 DO 500 LB=1,NLB
0050 DO 500 LC=1,NLC
0051 WRITE(1,4416) LA

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0052 4416 FORMAT ( "FACTOR A, LEVEL: ", I5 )
0053 WRITE(1,4417) LB
0054 4417 FORMAT ( "FACTOR B, LEVEL: ", I5 )
0055 WRITE(1,4418) LC
0056 4418 FORMAT ( "FACTOR C, LEVEL: ", I5 )
0057 WRITE(1,4419)
0058 4419 FORMAT ( "ENTER # SS THIS CELL: " )
0059 READ(1,*) NS(LA, LB, LC)
0060 K=NS(LA, LB, LC)
0061 IF(IPT0.EQ.1)WRITE(IUNIT,1)LA, LB, LC
0062 1 FORMAT(" LEVEL: ", I3, " RAW DATA")
0063 DO 499 N=1, K
0064 CALL READF(IB, IER, IBUF)
0065 CALL CODE
0066 READ(IBUF, IFMT)RDATA
0067 IF(IPT0.EQ.1)WRITE(IUNIT, IFMT)RDATA
0068 TSS=TSS+1
0069 S2(LA, LB, LC)=S2(LA, LB, LC)+RDATA
0070 SX2(LA, LB, LC)=SX2(LA, LB, LC)+RDATA**2
0071 S3=S3+RDATA**2
0072 S4=S4+RDATA
0073 S6(LA)=S6(LA)+RDATA
0074 NS6(LA)=NS6(LA)+1
0075 S7(LB)=S7(LB)+RDATA
0076 NS7(LB)=NS7(LB)+1
0077 S8(LC)=S8(LC)+RDATA
0078 NS8(LC)=NS8(LC)+1
0079 S9(LA, LB)=S9(LA, LB)+RDATA
0080 NS9(LA, LB)=NS9(LA, LB)+1
0081 S10(LA, LC)=S10(LA, LC)+RDATA
0082 NS10(LA, LC)=NS10(LA, LC)+1
0083 S11(LB, LC)=S11(LB, LC)+RDATA
0084 NS11(LB, LC)=NS11(LB, LC)+1
0085 499 CONTINUE
0086 500 CONTINUE
0087 DO 501 I1=1, NLA
0088 DO 501 I2=1, NLB
0089 DO 501 I3=1, NLC
0090 ANS=NS(I1, I2, I3)
0091 XBAR(I1, I2, I3)=S2(I1, I2, I3)/ANS
0092 SD(I1, I2, I3)=DSQRT((ANS*SX2(I1, I2, I3)-
0093 *S2(I1, I2, I3)**2)/(ANS*(ANS-1.)))
0094 501 CONTINUE
0095 WRITE(IUNIT, 502)((I1, I2, I3, NS(I1, I2, I3), S2(I1, I2, I3),
0096 *SX2(I1, I2, I3), XBAR(I1, I2, I3), SD(I1, I2, I3), I3=1, NLC), I2=1, NLB),
0097 *I1=1, NLA)
0098 502 FORMAT("O CELL      N      SUMX      SUMX2      MEAN",
0099 *9X, "SD", /, (3I2, 3X, I4, 3X, 4(1X, F10.3)))
0100 CI=S4**2/TSS
0101 SST=S3-CT
0102 DO 601 LA=1, NLA
0103 601 SSA=SSA+S6(LA)**2/NS6(LA)
0104 SSA=SSA-CT
0105 DO 701 LB=1, NLB

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0106 701  SSB=SSB+S7(LB)**2/NS7(LB)
0107      SSB=SSB-CT
0108      DO 801 LC=1,NLC
0109 801  SSC=SSC+S8(LC)**2/NS8(LC)
0110      SSC=SSC-CT
0111      DO 901 LA=1,NLA
0112      DO 901 LB=1,NLB
0113 901  SSAB=SSAB+S9(LA,LB)**2/NS9(LA,LB)
0114      SSAB=SSAB-SSA-SSB-CT
0115      DO 1001 LA=1,NLA
0116      DO 1001 LC=1,NLC
0117 1001 SSAC=SSAC+S10(LA,LC)**2/NS10(LA,LC)
0118      SSAC=SSAC-SSA-SSC-CT
0119      DO 1101 LB=1,NLB
0120      DO 1101 LC=1,NLC
0121 1101 SSBC=SSBC+S11(LB,LC)**2/NS11(LB,LC)
0122      SSBC=SSBC-SSB-SSC-CT
0123      DO 1201 LA=1,NLA
0124      DO 1201 LB=1,NLB
0125      DO 1201 LC=1,NLC
0126 1201 SSABC=SSABC+S2(LA,LB,LC)**2/NS(LA,LB,LC)
0127      SSABC=SSABC-SSA-SSB-SSC-SSAB-SSAC-SSBC-CT
0128      SSER=SSS-SSA-SSB-SSC-SSAB-SSAC-SSBC-SSABC
0129      DFT=TSS-1
0130      DFA=NLA-1
0131      DFB=NLB-1
0132      DFC=NLC-1
0133      DFAB=DFA*DFB
0134      DFAC=DFA*DFC
0135      DFBC=DFB*DFC
0136      DFABC=DFA*DFB*DFC
0137      DFER=DFT-DFA-DFB-DFC-DFAB-DFAC-DFBC-DFABC
0138      MSA=SSA/DFA
0139      MSB=SSB/DFB
0140      MSC=SSC/DFC
0141      MSAB=SSAB/DFAB
0142      MSAC=SSAC/DFAC
0143      MSBC=SSBC/DFBC
0144      MSABC=SSABC/DFABC
0145      MSER=SSER/DFER
0146      FA=MSA/MSER
0147      FB=MSB/MSER
0148      FC=MSC/MSER
0149      FAB=MSAB/MSER
0150      FAC=MSAC/MSER
0151      FBC=MSBC/MSER
0152      FABC=MSABC/MSER
0153      F=FA
0154      DF1=DFA
0155      DF2=DFER
0156      CALL FPROB(F,DF1,DF2,Z,PA)
0157      F=FB
0158      DF1=DFB
0159      DF2=DFER
0160      CALL FPROB(F,DF1,DF2,Z,PB)

```



```

0161      F=FC
0162      DF1=DFC
0163      DF2=DFER
0164      CALL FPROB(F,DF1,DF2,Z,PC)
0165      F=FAB
0166      DF1=DFAB
0167      DF2=DFER
0168      CALL FPROB(F,DF1,DF2,Z,PAB)
0169      F=FAC
0170      DF1=DFAC
0171      DF2=DFER
0172      CALL FPROB(F,DF1,DF2,Z,PAC)
0173      F=FBC
0174      DF1=DFBC
0175      DF2=DFER
0176      CALL FPROB(F,DF1,DF2,Z,PBC)
0177      F=FABC
0178      DF1=DFABC
0179      DF2=DFER
0180      CALL FPROB(F,DF1,DF2,Z,PABC)
0181      WRITE(IUNIT,1701)SST,DFT,SSA,DFA,MSA,FA,PA,SSB,DFB,MSB,FB,PB,
0182      $SSC,DFC,MSC,FC,PC,SSAB,DFAB,MSAB,FAB,PAB,SSAC,DFAC,MSAC,FAC,
0183      $PAC,SSBC,DFBC,
0184      $MSBC,FBC,PBC,SSABC,DFABC,MSABC,FABC,PABC,SSER,DFER,MSER
0185 1701  FORMAT(/,3X,"SOURCE",9X,"SS",5X,"DF",6X,"MS",10X,"F",7X,"P"/,
0186      $"      TOTAL",5X,F10.3,F5.0/3X,"FACTOR A",2X,F10.3,F5.0,2F10.3,
0187      $F10.6/3X,"FACTOR B",2X,F10.3,F5.0,2F10.3,F10.6/3X,"FACTOR C",
0188      $2X,F10.3,F5.0,2F10.3,F10.6/3X,"A * B",5X,F10.3,F5.0,2F10.3,
0189      $F10.6/,
0190      $3X,"A * C",5X,F10.3,F5.0,2F10.3,F10.6/3X,"B * C",5X,F10.3,F5.0,
0191      $2F10.3,F10.6/3X,"A * B * C",1X,F10.3,F5.0,2F10.3,F10.6/3X,
0192      $"ERROR",5X,F10.3,F5.0,F10.3)
0193      CALL CLOSE(IB,IER)
0194      END
0195      END$

```

AV31C (SPF-PQ.R) (Three-way Split Plot ANOVA, One Repeated Measure)

Purpose:

This program performs a three-way split-plot mixed analysis of variance with repeated measures on one factor.

Mathematical Model:

The model for this design is:

$$X_{ijklm} = \mu + A_i + B_j + C_k + AC_{ik} + AB_{ij} + BC_{jk} + ABC_{ijk} + \pi_m(ij) + BD_{km(ij)} + E_o(ijkm)$$

The hypotheses to be tested are:

- Ho: $A_i = 0$ for all i
- Ho: $B_j = 0$ for all j
- Ho: $C_k = 0$ for all k
- Ho: $AB_{ij} = 0$ for all ij
- Ho: $AC_{ik} = 0$ for all ik
- Ho: $BC_{jk} = 0$ for all jk
- Ho: $ABC_{ijk} = 0$ for all ijk

The mixed model (Model III) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

		C ₁	C ₂	C ₃
A ₁	B ₁	S ₁	S ₁	S ₁
	B ₂	S ₂	S ₂	S ₂
A ₂	B ₁	S ₃	S ₃	S ₃
	B ₂	S ₄	S ₄	S ₄

S represents a set of subjects

1. There are three Factors (A,B, and C) with p,q,r levels of treatments respectively. Factor A and B are designated as between blocks or nonrepeated measures. Factor C is the within block or repeated measure. The above example includes two levels of Factor A, two levels of Factor B, and three levels of Factor C.
2. Subjects from a common population are randomly assigned to the AB treatments. After this, levels of treatment C are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, index for Factor C first, then B, then subjects, and finally A. (For example, record one contains subject one, cell abc_{111} , $abc_{112} \dots$, abc_{11r} ; second record is subject one abc_{121} , $abc_{122} \dots$, abc_{12r} ; records continue for subject one until abc_{1q1} , $abc_{1q2} \dots$, abc_{1qr} have been entered. The remaining subjects in Factor A₁ should be entered in the same manner. Repeat the same procedures for subjects in Factor A_p.) A printout of the raw data would show r data points per line.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. levels of Factor A (maximum 9)
 - b. levels of Factor B (maximum 9)
 - c. levels of Factor C (maximum 9)
 - d. number of subjects per AB cell (maximum 32767)
 - e. name of data file
 - f. format of data file

5. Printout gives:

- a. raw data by group (optional)
- b. for each group: N , Σx , Σx^2 , $\bar{X}$, and SD (unbiased estimate)
- c. ANOVA source table

Comments:

Program uses least squares analysis for unequal AB cell sizes. This ANOVA design permits interaction effects to be evaluated. In a split-plot design, estimates of the within block (Factor C, interactions AC, BC, and ABC) effects are more accurate than estimates of the between-block (Factor A, Factor B, and interaction AB) effects. If an experimenter's primary interest is in the within-block effects, a split-plot design is more powerful than a randomized factorial block design (AV33). However, if equal precision for all treatment effects is desired the average power of a randomized factorial block design is greater. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested from data in Roger E. Kirk, Experimental Design for the Behavior Sciences, Wadsworth Publishing Company, 1968, pp. 284-287.

The accuracy of this program is less than that obtained by the Statistical Analysis System and by the Statistical Package for the Social Sciences. The data analysis output is only accurate to six digit places instead of ten digits.

RU,AV31C
 AV31C OR SPF- PQ.R
 THREE FACTOR MIXED DESIGN: REPEATED MEASURES ON ONE FACTOR
 NOTE: PROGRAM CALCULATORS LEAST SQUARES
 SOLUTION IF UNEQUAL CELL N'S
 NOTE: ON INPUT DATA READ SEQUENCE, INDEX FOR REPEATED
 MEASURES FACTOR (C) VARIES MOST RAPIDLY, INDEX FOR
 FACTOR B VARIES NEXT, THEN INDEX FOR FACTOR A VARIES.
 PROGRAM EXPECTS ALL DATA TO BE IN ONE MATRIX FILE.
 NOTE: MAX 9 * 9 * 9 DESIGN.
 ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
 6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO
 1
 ENTER INPUT DATA FILE NAME:
 #AV32
 ENTER INPUT DATA FORMAT:
 (4(4X,F10.4))

 ENTER # LEVELS FACTOR A:
 2
 ENTER # LEVELS FACTOR B:
 2
 ENTER # LEVELS FACTOR C (RPT MS FACTOR):
 4
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 1
 ENTER # SS THIS CELL:
 2
 FACTOR A, LEVEL: 1
 FACTOR B, LEVEL: 2
 ENTER # SS THIS CELL:
 2
 FACTOR A, LEVEL: 2
 FACTOR B, LEVEL: 1
 ENTER # SS THIS CELL:
 2
 FACTOR A, LEVEL: 2
 FACTOR B, LEVEL: 2
 ENTER # SS THIS CELL:
 2
 :

LEVEL:	1	1	RAW DATA		
	3.0000		4.0000	7.0000	7.0000
	6.0000		5.0000	8.0000	8.0000
LEVEL:	1	2	RAW DATA		
	3.0000		4.0000	7.0000	9.0000
	3.0000		3.0000	6.0000	8.0000
LEVEL:	2	1	RAW DATA		
	1.0000		2.0000	5.0000	10.0000
	2.0000		3.0000	6.0000	10.0000
LEVEL:	2	2	RAW DATA		
	2.0000		4.0000	5.0000	9.0000
	2.0000		3.0000	6.0000	11.0000

CELL	N	SUMX	SUMX2	MEAN/	SD
1 1 1	2	9.000	45.000	4.500	2.121
1 1 2	2	9.000	41.000	4.500	.707
1 1 3	2	15.000	113.000	7.500	.707
1 1 4	2	15.000	113.000	7.500	.707
1 2 1	2	6.000	18.000	3.000	.000
1 2 2	2	7.000	25.000	3.500	.707
1 2 3	2	13.000	85.000	6.500	.707
1 2 4	2	17.000	145.000	8.500	.707
2 1 1	2	3.000	5.000	1.500	.707
2 1 2	2	5.000	13.000	2.500	.707
2 1 3	2	11.000	61.000	5.500	.707
2 1 4	2	20.000	200.000	10.000	.000
2 2 1	2	4.000	8.000	2.000	.000
2 2 2	2	7.000	25.000	3.500	.707
2 2 3	2	11.000	61.000	5.500	.707
2 2 4	2	20.000	202.000	10.000	1.414

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
BETWEEN SUBJECTS	12.500	7.			
FACTOR A	3.125	1.	3.125	1.724	.259214
FACTOR B	.125	1.	.125	.069	.799328
A * B	2.000	1.	2.000	1.103	.354230
ERROR B	7.250	4.	1.812		
WITHIN SUBJECTS	223.000	24.			
FACTOR C	194.500	3.	64.833	163.789	.000001
A * C	19.375	3.	6.458	16.316	.000318
B * C	1.375	3.	.458	1.158	.366568
A * B * C	3.000	3.	1.000	2.526	.106246
ERROR W	4.750	12.	.396		

*AV31C T=00004 IS ON CR00002 USING 00030 BLKS R=0238

```

0001  FTN4,L
0002      PROGRAM AV31C
0003      DOUBLE PRECISION SX2(8,8,8),SD(8,8,8),XBAR(8,8,8),TSS,S4,S5,
0004      $GT,S9,CT,SST,SSB,SSFA,SSFB,SSAB,ERB,SSW,SSFC,SSAC,SSBC,SSABC,
0005      $ERM,DFT,DFB,DFFA,DFFB,DFAB,DFERB,DFW,DFFC,DFAC,DFBC,DFABC,
0006      $DFERM,FA,FB,FAB,FC,FAC,FBC,FABC,F,DF1,DF2,Z,PA,PB,PAB,PC,
0007      $PAC,PAC,PABC
0008      DOUBLE PRECISION DVEC(8),S2(8),S3(8,8),S10(8),S11(8),S15(8),
0009      $S16(8,8),S17(8,8),S18(8,8,8)
0010      DOUBLE PRECISION MSA,MSB,MSAB,MSERB,MSW,MSC,MSAC,MSBC,MSABC,
0011      CHSERW
0012      DIMENSION NSS(8,8),NS16(8),NS17(8),IFMT(20),IB(272),IBUF(256)
0013      DIMENSION INFILE(3)
0014      WRITE(1,4400)
0015  4400  FORMAT("AV31C OR SP5- PQ.R",/,
0016      C"THREE FACTOR MIXED DESIGN: REPEATED MEASURES ON ONE FACTOR",/,
0017      C"      NOTE: PROGRAM CALCULATES LEAST SQUARES" ,/,
0018      C"      SOLUTION IF UNEQUAL CELL N'S" ,/,
0019      C"      NOTE: ON INPUT DATA READ SEQUENCE, INDEX FOR REPEATED")
0020      WRITE(1,4405)
0021  4405  FORMAT("      MEASURES FACTOR (C) VARIES MOST RAPIDLY, ",
0022      $"INDEX FOR",/,
0023      C"      FACTOR B VARIES NEXT, THEN INDEX FOR FACTOR "
0024      $,"A VARIES.",/,
0025      C"      PROGRAM EXPECTS DATA TO BE IN ONE MATRIX FILE.",/,
0026      C"      NOTE: MAX 8 * 8 * 8 DESIGN." )
0027  8975  WRITE(1,4409)
0028  4409  FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: " )
0029      READ(1,*) IUNIT
0030      IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 8975
0031      WRITE(1,4410)
0032  4410  FORMAT("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO ")
0033      READ(1,*) IPTO
0034      WRITE(1,4411)
0035  4411  FORMAT ( "ENTER INPUT DATA FILE NAME:" )
0036      READ(1,898)INFILE
0037  898   FORMAT(3A2)
0038      WRITE(1,4412)
0039  4412  FORMAT ( "ENTER INPUT DATA FORMAT:" )
0040      READ(1,876)IFMT
0041  876   FORMAT(20A2)
0042      IDCBS=256
0043      CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
0044      IF(IER.GE.0) GO TO 908
0045      WRITE(1,564) INFILE,IER
0046  564   FORMAT(5X,3A2," FAILED TO OPEN , IER = ",I5)
0047      STOP 564
0048  908   WRITE(1,4413)
0049  4413  FORMAT ( "ENTER # LEVELS FACTOR A: " )
0050      READ(1,*) NLBA
0051      WRITE(1,4414)

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0052 4414 FORMAT ( "ENTER # LEVELS FACTOR B: " )
0053      READ(1,*) NLBB
0054      WRITE(1,4415)
0055 4415 FORMAT ( "ENTER # LEVELS FACTOR C (RPT NS FACTOR): " )
0056      READ(1,*) NLW
0057      DO 900 LA=1,NLBA
0058      DO 900 LB=1,NLBB
0059      WRITE(1,4416) LA
0060 4416 FORMAT ( "&FACTOR A, LEVEL: ",I5 )
0061      WRITE(1,4417) LB
0062 4417 FORMAT ( "&FACTOR B, LEVEL: ",I5 )
0063      WRITE(1,4418)
0064 4418 FORMAT ( "&ENTER # SS THIS CELL: " )
0065      READ(1,*) NSS(LA,LB)
0066      NS=NSS(LA,LB)
0067      TSS=TSS+NS
0068      NS16(LA)=NS16(LA)+NSS(LA,LB)
0069      NS17(LB)=NS17(LB)+NSS(LA,LB)
0070      IF(IPT0.EQ.1)WRITE(IUNIT,1)LA,LB
0071 1      FORMAT(" LEVEL: ",2I4," RAW DATA")
0072      DO 900 N=1,NS
0073      S4=0
0074      CALL READF(IB,IER,IBUF)
0075      CALL CODE
0076      READ(IBUF,IFMT)(DVEC(IXW),IXW=1,NLW)
0077      IF(IPT0.EQ.1)WRITE(IUNIT,IFMT)(DVEC(IXW),IXW=1,NLW)
0078      DO 899 LW=1,NLW
0079      S2(LW)=S2(LW)+DVEC(LW)
0080      S3(LA,LB)=S3(LA,LB)+DVEC(LW)
0081      S4=S4+DVEC(LW)
0082      S5=S5+DVEC(LW)**2
0083      S10(LA)=S10(LA)+DVEC(LW)
0084      S11(LB)=S11(LB)+DVEC(LW)
0085      S15(LW)=S15(LW)+DVEC(LW)
0086      S16(LA,LW)=S16(LA,LW)+DVEC(LW)
0087      S17(LB,LW)=S17(LB,LW)+DVEC(LW)
0088      S18(LA,LB,LW)=S18(LA,LB,LW)+DVEC(LW)
0089      SX2(LA,LB,LW)=SX2(LA,LB,LW)+DVEC(LW)**2
0090 899      CONTINUE
0091      GT=GT+S4
0092      S9=S9+S4**2/NLW
0093 900      CONTINUE
0094      DO 8994 IX1=1,NLBA
0095      DO 8994 IX2=1,NLBB
0096      DO 8994 IX3=1,NLW
0097      ANS=NSS(IX1,IX2)
0098      XBAR(IX1,IX2,IX3)=S18(IX1,IX2,IX3)/ANS
0099      SD(IX1,IX2,IX3)=DSQRT((ANS*SX2(IX1,IX2,IX3)-
0100      $S18(IX1,IX2,IX3)**2)/(ANS*(ANS-1.)))
0101 8994      CONTINUE
0102      WRITE(IUNIT,8995)((IX1,IX2,IX3,NSS(IX1,IX2),S18(IX1,IX2,IX3),
0103      $SX2(IX1,IX2,IX3),XBAR(IX1,IX2,IX3),SD(IX1,IX2,IX3),IX3=1,NLW),
0104      $IX2=1,NLBB),IX1=1,NLBA)

```



```

0105 8995 FORMAT('O CELL      N      SUMX      SUMX2      MEAN',
0106      *      SD'/',(3I2,3X,14,3X,4(1X,F10.3)))
0107      CT=CT+2/(TSS*NLW)
0108      SST=S5-CT
0109      SSB=S9-CT
0110      DO 1000 LA=1,NLBA
0111 1000  SSFA=SSFA+S10(LA)**2/(NS16(LA)*NLW)
0112      SSFA=SSFA-CT
0113      DO 1100 LB=1,NLBB
0114 1100  SSFB=SSFB+S11(LB)**2/(NS17(LB)*NLW)
0115      SSFB=SSFB-CT
0116      DO 1299 LA=1,NLBA
0117      DO 1299 LB=1,NLBB
0118 1299  SSAB=SSAB+S13(LA, LB)**2/(NSS(LA, LB)*NLW)
0119      SSAB=SSAB-SSFA-SSFB-CT
0120 1300  ERB=SSB-SSFA-SSFB-SSAB
0121 1400  SSW=SST-SSB
0122      DO 1599 LW=1,NLW
0123 1599  SSFC=SSFC+S15(LW)**2/TSS
0124      SSFC=SSFC-CT
0125      SSAC=0
0126      DO 1699 LA=1,NLBA
0127      DO 1699 LW=1,NLW
0128 1699  SSAC=SSAC+S16(LA, LW)**2/NS16(LA)
0129      SSAC=SSAC-SSFA-SSFC-CT
0130      DO 1799 LB=1,NLBB
0131      DO 1799 LW=1,NLW
0132 1799  SSBC=SSBC+S17(LB, LW)**2/NS17(LB)
0133      SSBC=SSBC-SSFB-SSFC-CT
0134      DO 1899 LA=1,NLBA
0135      DO 1899 LB=1,NLBB
0136      DO 1899 LW=1,NLW
0137 1899  SSABC=SSABC+S18(LA, LB, LW)**2/NSS(LA, LB)
0138      SSABC=SSABC-SSFA-SSFB-SSAB-SSFC-SSAC-SSBC-CT
0139      ERU=SSW-SSFC-SSAC-SSBC-SSABC
0140      DFT=TSS*NLW-1
0141      DFB=TSS-1
0142      DFFA=NLBA-1
0143      DFFB=NLBB-1
0144      DFAB=DFFA*DFFB
0145      DFERB=DFB-DFFA-DFFB-DFAB
0146      DFW=DFT-DFB
0147      DFFC=NLW-1
0148      DFAC=DFFC*DFFA
0149      DFBC=DFFC*DFFB
0150      DFABC=DFFA*DFFB*DFFC
0151      DFERU=DFW-DFFC-DFAC-DFBC-DFABC
0152      NSA=SSFA/DFFA
0153      NSB=SSFB/DFFB
0154      NSAB=SSAB/DFAB
0155      NSERB=ERB/DFERB
0156      NSW=SSW/DFW
0157      NSC=SSFC/DFFC
0158      NSAC=SSAC/DFAC
0159      NSBC=SSBC/DFBC
0160      NSABC=SSABC/DFABC
0161      NSERU=ERU/DFERU

```

```

0162      FA=MSA/MSERB
0163      FB=MSB/MSERB
0164      FAB=MSAB/MSERB
0165      FC=MSC/MSERW
0166      FAC=MSAC/MSERW
0167      FBC=MSBC/MSERW
0168      FABC=MSABC/MSERW
0169      F=FA
0170      DF1=DFFA
0171      DF2=DFERB
0172      CALL FPROB(F,DF1,DF2,Z,PA)
0173      F=FB
0174      DF1=DFFB
0175      DF2=DFERB
0176      CALL FPROB(F,DF1,DF2,Z,PB)
0177      F=FAB
0178      DF1=DFAB
0179      DF2=DFERB
0180      CALL FPROB(F,DF1,DF2,Z,PAB)
0181      F=FC
0182      DF1=DFFC
0183      DF2=DFERW
0184      CALL FPROB(F,DF1,DF2,Z,PC)
0185      F=FAC
0186      DF1=DFAC
0187      DF2=DFERW
0188      CALL FPROB(F,DF1,DF2,Z,PAC)
0189      F=FBC
0190      DF1=DFBC
0191      DF2=DFERW
0192      CALL FPROB(F,DF1,DF2,Z,PBC)
0193      F=FABC
0194      DF1=DFABC
0195      DF2=DFERW
0196      CALL FPROB(F,DF1,DF2,Z,PABC)
0197      WRITE(IUNIT,2201)SST,DFT,SSB,DFB,SSFA,DFFA,MSA,FA,PA,SSFB,DFFB,
0198      $MSB,FB,PB,SSAB,DFAB,MSAB,FAA,PAB,ERB,DFERB,MSERB,SSW,DFW,SSFC,
0199      $DFFC,MSC,FC,PC,SSAC,DFAC,MSAC,FAC,PAC,SSBC,DFBC,MSBC,FBC,PBC,
0200      $SSABC,DFABC,MSABC,FABC,PABC,ERW,DFERW,MSERW
0201 2201  FORMAT("0",8X,"SOURCE",11X,"SS",5X,"DF",5X,"MS",9X,"F",11X,"P"
0202      $,"/" TOTAL",14X,F10.3,F5.0/" BETWEEN SUBJECTS ",F10.3,F5.0/5X,
0203      $"FACTOR A",7X,F10.3,F5.0/2F10.3,F12.6/5X,"FACTOR B",7X,F10.3,
0204      $F5.0/2F10.3,F12.6/5X,"A * B",10X,F10.3,F5.0/2F10.3,F12.6/7X,
0205      $"ERROR B",6X,F10.3,
0206      $F5.0,F10.3/7" WITHIN SUBJECTS",2X,F10.3,F5.0/5X,"FACTOR C",
0207      $7X,F10.3,F5.0/2F10.3,F12.6/5X,"A * C",10X,F10.3,F5.0/2F10.3,
0208      $F12.6/5X,"B * C",10X,F10.3,F5.0/2F10.3,F12.6/75X,"A * B * C"
0209      $,6X,F10.3,F5.0/2F10.3,F12.6/77X,"ERROR W",6X,F10.3,F5.0,F10.3)
0210      CALL CLOSE (IB,IER)
0211      END
0212      END$

```

AV328C (SPF-P.QR) (Three-way Split Plot ANOVA, Two Repeated Measures)

Purpose:

This program performs a three-way mixed split plot analysis of variance with repeated measures on two factors.

Mathematical Model:

The model for this design is:

$$X_{ijklm} = \mu + A_i + B_j + C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + \pi_m(i) + B\pi_{jm}(i) + C\pi_{km}(i) + BC\pi_{jkm}(i) + E_{o(ijkm)}$$

The hypotheses to be tested are:

- Ho: $A_i = 0$ for all i
- Ho: $B_j = 0$ for all j
- Ho: $C_k = 0$ for all k
- Ho: $AB_{ijk} = 0$ for all ij
- Ho: $AC_{ik} = 0$ for all ik
- Ho: $BC_{jk} = 0$ for all jk
- Ho: $ABC_{ijk} = 0$ for all ijk

The mixed model (Model III) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

	B ₁		B ₂	
	C ₁	C ₂	C ₁	C ₂
A ₁	S ₁	S ₁	S ₁	S ₁
A ₂	S ₂	S ₂	S ₂	S ₂

S represents a set of subjects

1. There are three Factors (A,B, and C) with p, q, r levels of treatment respectively. Factor A is designated as the between block or nonrepeated measure. Factors B and C are the within blocks or repeated measures. The above example includes two levels each of Factors A, B, and C.
2. Subjects from a common population are randomly assigned to the levels of Factor A. After this, levels of treatments B and C are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization or the presentation order.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, Factor C indexes first, then B, then subjects and finally A. (For example, record one contains subject one, cell abc_{111} , abc_{112} . . . , abc_{11r} , abc_{121} , abc_{122} . . . , abc_{12r} . . . , abc_{1q1} , abc_{1q2} . . . , abc_{1qr} ; the next record contains the same information for subject two. The remaining subjects in Factor A_1 should be entered in the same manner. Repeat the same procedure for subjects in A_p .) A printout of the raw data would show qr data points.
2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. levels of Factor A (maximum 11)
 - b. levels of Factor B (maximum 11)
 - c. levels of Factor C (or groups) (maximum 11)
 - d. number of subjects per group (maximum 32767)
 - e. data file name
 - f. format of data file

5. Printout gives:

- a. raw data by group (optional)
- b. for each group: N , Σx , Σx^2 , $\bar{X}$, and SD (unbiased estimate)
- c. ANOVA source table

Comments:

Program uses least squares analysis for unequal cell sizes on Factor A. This ANOVA design permits interaction effects to be evaluated. In a split-plot design, estimates of the within-block (Factor B, Factor C, interactions AB, AC, BC, and ABC) effects are more accurate than estimates of between-block (Factor A) effects. If an experimenter's primary interest is in the within-block effects, a split-plot design is more powerful than a randomized factorial block design (AV33). However, if equal precision for all treatment effects is desired, the average power of a randomized factorial block design is greater. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested from data in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 298-302.

The accuracy of this program is less than that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences. The data analysis output is only accurate to six digit places instead of ten digits.

RU,AV32
AV32AB OR SPF P.QR
REF: BRUNING & KINTZ, 1968
SECTION 2.9

THREE-FACTOR MIXED DESIGN: REPEATED MEASURES ON TWO FACTORS

NOTE: PROGRAM CALCULATES LEAST SQUARES
SOLUTION IF UNEQUAL CELL N's

NOTE: ON INPUT DATA READ SEQUENCE, INDEX FOR 2ND WITHIN
FACTOR (C) VARIES MOST RAPIDLY, INDEX FOR 1ST WITHIN
FACTOR (B) VARIES NEXT, THEN INDEX FOR THE BETWEEN
FACTOR (A) VARIES. PROGRAM EXPECTS ALL DATA TO
BE IN ONE MATRIX FILE.

NOTE: MAX 11 * 11 * 11 DESIGN.

ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:

6

DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO

1

ENTER INPUT FILE NAME:

#AV32

ENTER INPUT DATA FORMAT:

(4(4X,F10.4))

ENTER # OF LEVELS ON FACTORS B & C, AND # OF GROUPS:

2,2,2

ENTER GP # AND # SS IN GROUP:

1,4

ENTER GP # AND # SS IN GROUP:

2,4

AV32 : STOP 0000

:

GROUP:	1	RAW DATA			
	3.0000	4.0000	7.0000	7.0000	
	6.0000	5.0000	8.0000	8.0000	
	3.0000	4.0000	7.0000	9.0000	
	3.0000	3.0000	6.0000	8.0000	
GROUP:	2	RAW DATA			
	1.0000	2.0000	5.0000	10.0000	
	2.0000	3.0000	6.0000	10.0000	
	2.0000	4.0000	5.0000	9.0000	
	2.0000	3.0000	6.0000	11.0000	

CELL	N	SUMX	SUMX2	MEAN	SD
1 1 1	4	15.000	63.000	3.750	1.500
1 1 2	4	16.000	66.000	4.000	.816
1 2 1	4	28.000	198.000	7.000	.816
1 2 2	4	32.000	258.000	8.000	.816
2 1 1	4	7.000	13.000	1.750	.500
2 1 2	4	12.000	38.000	3.000	.816
2 2 1	4	22.000	122.000	5.500	.577
2 2 2	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
BETWEEN SUBJECTS	12.500	7.			
GROUPS (A)	3.125	1.	3.125	2.000	.205762
ERROR (A)	9.375	6.	1.562		
WITHIN SUBJECTS	223.000	24.			
FACTOR B	162.000	1.	162.000	199.385	.000095
FACTOR C	24.500	1.	24.500	61.895	.000521
A * B	6.125	1.	6.125	7.538	.032735
A * C	10.125	1.	10.125	25.579	.002835
B * C	8.000	1.	8.000	25.600	.002831
A * B * C	3.125	1.	3.125	10.000	.019275
ERROR (B)	4.875	6.	.813		
ERROR (C)	2.375	6.	.396		
ERROR (BC)	1.875	6.	.313		

"AV32B T=00004 IS ON CR00002 USING 00033 BLKS R=0266

```

0001 FTH4,L
0002 PROGRAM AV32B
0003 C THISPROGRAM NAME USED TO BE AV32BC BUT NAME WAS TO LONG
0004 DOUBLE PRECISION MSGPS,MSERB,MSA,MSB,MSAXC,MSBXC,MSAXB,MSASC,
0005 $MSER1,MSER2,MSER3,C,A,B,AC,BC,AB,ABC,F,DF1,DF2,PC,PA,PB,PAC,
0006 $PBC,PAB,PBC,PABC,TSS,SUM8,SUM4,SUM3,SUM18B,SUM8B,SUM19B,XBAR,
0007 $SD,CT,SST,SUM7B,SSGPS,SSB,SSERRB,SSW,SSFA,SSFB,SSAXC,SSBXC,
0008 $SSAXB,SSABC,SSEMS,SSER1,SSER2,SSER3,DFT,DFB,DFGPS,DFERB,DFW,
0009 $DFFA,DFFB,DFAXC,DFBXC,DFAXB,DFABC,DFERRW,DFER1,DFER2,DFER3
0010 DOUBLE PRECISION SX2(8,8,8),DMTRX(8,8),
0011 $SUM18(8),SUM19(8),SUM2(8,8,8),SUM11(8),SUM12(8),
0012 $SUM13(8,8),SUM14(8,8),SUM15(8,8),SUM7A(8)
0013 DIMENSION INFILE(3),IFMT(20),IB(272),IBUF(256),NSS(10)
0014 WRITE(1,4400)
0015 4400 FORMAT ( "AV32BC OR SPF P.QR",/,
0016 C"REF: BRUNING & KINTZ, 1968" ,/,
0017 C"SECTION 2.9" ,/,
0018 C"THREE-FACTOR MIXED DESIGN: REPEATED MEASURES ON TWO FACTORS",/,
0019 C" NOTE: PROGRAM CALCULATES LEAST SQUARES" ,/,
0020 C" SOLUTION IF UNEQUAL CELL N'S" )
0021 WRITE(1,4406)
0022 4406 FORMAT(" NOTE: ON INPUT DATA READ SEQUENCE, INDEX FOR 2ND "
0023 $,"WITHIN",/,
0024 C" FACTOR (C) VARIES MOST RAPIDLY, INDEX FOR 1ST WITHIN",/,
0025 C" FACTOR (B) VARIES NEXT, THEN INDEX FOR THE BETWEEN",/,
0026 C" FACTOR (A) VARIES. PROGRAM EXPECTS ALL DATA TO",/,
0027 C" BE IN ONE MATRIX FILE." ,/,
0028 C" NOTE: MAX 8 * 8 * 8 DESIGN" )
0029 WRITE(1,4412)
0030 4412 FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: " )
0031 READ(1,*) IUNIT
0032 WRITE(1,4413)
0033 4413 FORMAT("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO " )
0034 READ(1,*) IPTO
0035 WRITE(1,4414)
0036 4414 FORMAT ( "ENTER INPUT FILENAME: " )
0037 READ(1,1005)INFILE
0038 1005 FORMAT(3A2)
0039 IDCBS=256
0040 WRITE(1,4415)
0041 4415 FORMAT ( "ENTER INPUT DATA FORMAT: " )
0042 READ(1,1001)IFMT
0043 1001 FORMAT(20A2)
0044 CALL OPEN(18,IER,INFILE,3,0,-2,IDCBS)
0045 IF(IER.GE.0) GO TO 234
0046 WRITE(1,546) INFILE,IER
0047 546 FORMAT(5X,3A2,5X," FAILED TO OPEN , IER = ",I5)
0048 STOP 546

```



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0049 234 WRITE(1,416)
0050 4416 FORMAT("ENTER # OF LEVELS ON FACTORS B & C, AND # OF GROUPS:")
0051 READ(1,*) NLF1R,NLF2R,NGPS
0052 DO 60 I3=1,NGPS
0053 WRITE(1,4417)
0054 4417 FORMAT("ENTER GP # AND # SS IN GROUP:")
0055 READ(1,*) NG,ISS(NG)
0056 IF(IPTD.EQ.1) WRITE(IUNIT,2) NG
0057 2 FORMAT("GROUP: ",I4," RAW DATA")
0058 K=NSS(NG)
0059 DO 60 N=1,K
0060 SUM8=0
0061 DO 57 I1=1,8
0062 SUM18(I1)=0
0063 SUM19(I1)=0
0064 57 CONTINUE
0065 CALL READF(IB,IER,IBUF)
0066 CALL CODE
0067 READ(IBUF,IFMT)((DMTRX(I1,I2),I2=1,NLF2R),I1=1,NLF1R)
0068 IF(IPTD.EQ.1)WRITE(IUNIT,IFMT)((DMTRX(I1,I2),I2=1,NLF2R),
0069 $I1=1,NLF1R)
0070 TSS=TSS+1.
0071 DO 59 I1=1,NLF1R
0072 DO 58 I2=1,NLF2R
0073 SUM8=SUM8+DMTRX(I1,I2)
0074 SUM18(I1)=SUM18(I1)+DMTRX(I1,I2)
0075 SUM19(I2)=SUM19(I2)+DMTRX(I1,I2)
0076 SUM2(I1,I2,NG)=SUM2(I1,I2,NG)+DMTRX(I1,I2)
0077 SUM4=SUM4+DMTRX(I1,I2)
0078 SUM3=SUM3+DMTRX(I1,I2)**2
0079 SX2(I1,I2,NG)=SX2(I1,I2,NG)+DMTRX(I1,I2)**2
0080 58 CONTINUE
0081 SUM18B=SUM18B+SUM18(I1)**2/NLF2R
0082 59 CONTINUE
0083 SUM8B=SUM8B+SUM8**2
0084 DO 11 I2=1,NLF2R
0085 SUM19B=SUM19B+SUM19(I2)**2/NLF1R
0086 11 CONTINUE
0087 60 CONTINUE
0088 WRITE(IUNIT,605)
0089 605 FORMAT("0 CELL N SUMX SUMX2 MEAN"
0090 $," SD")
0091 DO 61 I3=1,NGPS
0092 DO 61 I1=1,NLF1R
0093 DO 61 I2=1,NLF2R
0094 ANS=NSS(I3)
0095 XBAR=SUM2(I1,I2,I3)/ANS
0096 SD=DSQRT((ANS*SX2(I1,I2,I3)-(SUM2(I1,I2,I3)**2))/
0097 $X(ANS*(ANS-1.)))
0098 WRITE(IUNIT,606)I3,I1,I2,NSS(I3),SUM2(I1,I2,I3),
0099 $SX2(I1,I2,I3),XBAR,SD
0100 606 FORMAT(3I2,3X,I4,3X,4(1X,F10.3))
0101 61 CONTINUE
0102 CT=SUM4**2/(TSS*NLF1R*NLF2R)
0103 SST=SUM3-CT
0104 DO 79 I1=1,NGPS
0105 DO 79 I2=1,NLF1R
0106 DO 73 I3=1,NLF2R

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```

0107      SUM7A(I1)=SUM7A(I1)+SUM2(I2,I3,I1)
0108      SUM11(I2)=SUM11(I2)+SUM2(I2,I3,I1)
0109      SUM12(I3)=SUM12(I3)+SUM2(I2,I3,I1)
0110      SUM13(I2,I1)=SUM13(I2,I1)+SUM2(I2,I3,I1)
0111      SUM14(I3,I1)=SUM14(I3,I1)+SUM2(I2,I3,I1)
0112      SUM15(I2,I3)=SUM15(I2,I3)+SUM2(I2,I3,I1)
0113      SUM2(I2,I3,I1)=SUM2(I2,I3,I1)**2
0114  78      CONTINUE
0115      SUM7B=SUM7B+(SUM7A(I1)**2/(HSS(I1)*(NLF1R*NLF2R)))
0116  79      CONTINUE
0117      SSGPS=SUM7B-CT
0118      SSB=SUM8B/(NLF1R*NLF2R)-CT
0119      SSERRB=SSB-SSGPS
0120      SSM=SSB-SSB
0121      DO 119 I1=1,NLF1R
0122  119      SSFA=SSFA+SUM11(I1)**2/(TSS*NLF2R)
0123      SSFA=SSFA-CT
0124      DO 129 I1=1,NLF2R
0125  129      SSFB=SSFB+SUM12(I1)**2/(TSS*NLF1R)
0126      SSFB=SSFB-CT
0127      DO 139 I1=1,NLF1R
0128      DO 139 I2=1,NGPS
0129  139      SSAXC=SSAXC+SUM13(I1,I2)**2/(HSS(I2)*NLF2R)
0130      SSAXC=SSAXC-SSGPS-SSFA-CT
0131      DO 149 I1=1,NLF2R
0132      DO 149 I2=1,NGPS
0133  149      SSBXC=SSBXC+SUM14(I1,I2)**2/(HSS(I2)*NLF1R)
0134      SSBXC=SSBXC-SSGPS-SSFB-CT
0135      DO 159 I1=1,NLF1R
0136      DO 159 I2=1,NLF2R
0137  159      SSAXB=SSAXB+SUM15(I1,I2)**2/TSS
0138      SSAXB=SSAXB-SSFA-SSFB-CT
0139      DO 169 I1=1,NLF1R
0140      DO 169 I2=1,NLF2R
0141      DO 169 I3=1,NGPS
0142  169      SSABC=SSABC+SUM2(I1,I2,I3)/HSS(I3)
0143      SSABC=SSABC-SSGPS-SSFA-SSFB-SSAXC-SSBXC-SSAXB-CT
0144      SSEWS=SSM-SSFA-SSFB-SSAXC-SSBXC-SSAXB-SSABC
0145      SSER1=SUM18B-SSB-SSFA-SSAXC-CT
0146      SSER2=SUM19B-SSB-SSFB-SSBXC-CT
0147      SSER3=SSEWS-SSER1-SSER2
0148      DFT=TSS*NLF1R*NLF2R-1.
0149      DFB=TSS-1.
0150      DFGPS=NGPS-1.
0151      DFERB=DFB-DFGPS
0152      DFW=DFT-DFB
0153      DFFA=NLF1R-1.
0154      DFFB=NLF2R-1.
0155      DFAXC=DFGPS*DFFA
0156      DFBXC=DFGPS*DFFB
0157      DFAXB=DFFA*DFFB
0158      DFABC=DFFA*DFFB*DFGPS
0159      DFERRU=DFW-DFFA-DFFB-DFAXC-DFBXC-DFAXB-DFABC
0160      DO 219 I1=1,NGPS

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```

0161      DFER1=DFER1+DFFA*(NSS(I1)-1)
0162      DFER2=DFER2+DFFB*(NSS(I1)-1)
0163      DFER3=DFER3+DFFA*DFFB*(NSS(I1)-1)
0164  219  CONTINUE
0165      MSGPS=SSGPS/DFGPS
0166      MSERB=SSERRB/DFERB
0167      MSA=SSFA/DFFA
0168      MSB=SSFB/DFFB
0169      MSAXC=SSAXC/DFAXC
0170      MSBXC=SSBXC/DFBXC
0171      MSAXB=SSAXB/DFAXB
0172      MSABC=SSABC/DFABC
0173      MSER1=SSER1/DFER1
0174      MSER2=SSER2/DFER2
0175      MSER3=SSER3/DFER3
0176      C=MSGPS/MSERB
0177      A=MSA/MSER1
0178      B=MSB/MSER2
0179      AC=MSAXC/MSER1
0180      BC=MSBXC/MSER2
0181      AB=MSAXB/MSER3
0182      ABC=MSABC/MSER3
0183      F=C
0184      DF1=DFGPS
0185      DF2=DFERB
0186      CALL FPROB(F,DF1,DF2,Z,PC)
0187      F=A
0188      DF1=DFFA
0189      DF2=DFER1
0190      CALL FPROB(F,DF1,DF2,Z,PA)
0191      F=B
0192      DF1=DFFB
0193      DF2=DFER2
0194      CALL FPROB(F,DF1,DF2,Z,PB)
0195      F=AC
0196      DF1=DFAXC
0197      DF2=DFER1
0198      CALL FPROB(F,DF1,DF2,Z,PAC)
0199      F=BC
0200      DF1=DFBXC
0201      DF2=DFER1
0202      CALL FPROB(F,DF1,DF2,Z,PBC)
0203      F=AB
0204      DF1=DFAXB
0205      DF2=DFER3
0206      CALL FPROB(F,DF1,DF2,Z,PAB)
0207      F=ABC
0208      DF1=DFABC
0209      DF2=DFER3
0210      CALL FPROB(F,DF1,DF2,Z,PABC)
0211      WRITE(UNIT,1004)
0212  1004  FORMAT('***** SOURCE *****',5X,'SS',6X,'DF',9X,'MS',10X,'F',
0213          $7X,'P'/)

```

```

0214      WRITE(IUNIT,1003) SST,DFT,2*B,DFB,SSGPS,DFGPS,MSGPS,
0215      $C,PC,SSERRB,DFERB,MSERB,SSM,DFW,SSFA,DFFA,MSA,A,PA,
0216      $SSFB,DFFB,MSB,B,PB,SSAXC,DFAXC,MSAXC,AC,PAC,SSBXC,DFBXC,
0217      $MSBXC,BC,PBC,SSAXB,DFAXB,MSAXB,AB,PAB,SSABC,DFABC,MSABC,ABC,
0218      $PABC,SSER1,DFER1,MSER1,SSER2,DFER2,MSER2,SSER3,DFER3,MSER3
0219 1003  FORMAT("0TOTAL",14X,F10.3,F5.0/"    BETWEEN SUBJECTS",F11.3,
0220      $F5.75X,"GROUPS (A)",5X,F10.3,F5.74X,2F10.3,F10.6/7X,"ERROR(A)"
0221      $,5X,F10.3,F5.74X,F10.3/"0    WITHIN SUBJECTS",2X,F10.3,F5.75X,
0222      $"FACTOR B",7X,F10.3,F5.74X,2F10.3,F10.6/5X,"FACTOR C",7X,
0223      $F10.3,
0224      $F5.74X,2F10.3,F10.6/5X,"A X B",10X,F10.3,F5.74X,2F10.3,F10.6,
0225      $/5X,"A X C",10X,F10.3,F5.74X,2F10.3,F10.6/5X,"B X C",10X,
0226      $F10.3,
0227      $F5.74X,2F10.3,F10.6/5X,"A X B X C ",5X,F10.3,F5.74X,2F10.3,
0228      $F10.6/7X,"ERROR (B)",4X,F10.3,F5.0,4X,F10.3/7X,"ERROR (C)"
0229      $,4X
0230      $,F10.3,F5.74X,F10.3/7X,"ERROR (BC)",3X,F10.3,F5.74X,F10.3)
0231      CALL CLOSE(IB)
0232      STOP
0233      END
0234      END*

```

AV33 (RBF-P,Q,R) (Three-way ANOVA, Repeated Measures)

Purpose:

This program performs a three-way randomized factorial block analysis of variance.

Mathematical Model:

The model for this design is:

$$X_{ijm} = \mu + A_i + B_j + C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + \tau_m + E_{ijkm}$$

The hypotheses to be tested are:

- Ho: $A_i = 0$ for all i
- Ho: $B_j = 0$ for all j
- Ho: $C_k = 0$ for all k
- Ho: $AB_{ij} = 0$ for all ij
- Ho: $AC_{ik} = 0$ for all ik
- Ho: $BC_{jk} = 0$ for all jk
- Ho: $ABC_{ijk} = 0$ for all ijk

The fixed effect (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A ₁				A ₂			
B ₁		B ₂		B ₁		B ₂	
C ₁	C ₂	C ₁	C ₂	C ₁	C ₂	C ₁	C ₂
S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁

S represents a set of subjects

1. There are two Factors (A, B, C) with p, q, and r levels of treatments, respectively. The experiment consists of pqr treatment combinations. The above example includes two levels of each of Factors A, B, and C.

2. Subjects are randomly assigned to the pqr treatment combinations with each subject or a set of matched subjects receiving all combinations. The order of administration of the pqr combination is randomized independently for each subject. If sets of matched subjects are used, one subject from each set is randomly assigned to each treatment combination.
3. There should be more than one subject per pqr treatment combination.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, Factor C varies most rapidly, then Factor B, then subjects, and finally Factor A. (For example, record one contains subject one, treatments abc_{111} , abc_{112} . . . , abc_{11r} ; record two contains subject one, treatments abc_{121} , abc_{122} . . . , abc_{12r} ; records continue for subject one until abc_{1q1} , abc_{1q2} . . . , abc_{1qr} have been entered. The remaining subjects in Factor A should be entered in the same manner. Repeat the same procedures for subjects in Factor A_p.¹ A printout of the raw data would show r data points per line.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of levels of Factor A (see comments)
 - b. number of levels of Factor B (see comments)
 - c. number of levels of Factor C (see comments)
 - d. number of subjects per cell (treatment combination) (see comments)
 - e. name of data file
 - f. format of data file

5. Printout gives:

- a. raw data by group (optional)
- b. for each group: N , Σx , Σx^2 , $\bar{X}$, and SD (unbiased estimate)
- c. ANOVA source table

Comments:

This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the number of subjects necessary for the experiment.

Due to the limited amount of memory, the experimental design cannot exceed the following conditions:

1. $p \leq 10$; $q \leq 10$; $r \leq 10$
2. $n \leq 50$
3. $nqr \leq 1000$
4. $rn \leq 100$
5. $qn \leq 100$

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 239-240.

Single precision was used for this program. Accuracy of this program is less than that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences. The data analysis output is only accurate to six digit places instead of ten digits.

RU,AV33
RBF-P,Q,R OR AV33
THREE WAY ANOVA WITH REPEATED MEASURES ON ALL FACTORS.
ENTER NAME OF DATA FILE
#JRBF
ENTER FORMAT OF DATA
(2(2X,F8.4))

LEVELS OF A
2
LEVELS OF B
2
LEVELS OF C
2
SS/CELL
4
ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER
6
DO YOU WISH A PRINTOUT OF RAW DATA (1=YES, 0=NO)
0
:

CELL	N	SUMX	SUMX2	MEAN	SD
1 1 1	4	15.000	63.000	3.750	1.500
1 1 2	4	16.000	66.000	4.000	.816
1 2 1	4	28.000	198.000	7.000	.816
1 2 2	4	32.000	258.000	8.000	.816
2 1 1	4	7.000	13.000	1.750	.500
2 1 2	4	12.000	38.000	3.000	.816
2 2 1	4	22.000	122.000	5.500	.577
2 2 2	4	40.000	402.000	10.000	.816

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	3.125	1	3.125	4.953	.035
B	162.000	1	162.000	256.755	.000
C	24.500	1	24.500	38.830	.000
AB	6.125	1	6.125	9.708	.005
AC	10.125	1	10.125	16.047	.000
BC	8.000	1	8.000	12.679	.000
ABC	3.125	1	3.125	4.953	.035
RESIDUAL	13.250	21.	.631		
TOTAL	235.500	31.			

*AV33 T=00003 IS ON CR00002 USING 00024 BLKS R=0000

```

0001 FTH4,L
0002 PROGRAM AV33
0003 DOUBLE PRECISION SJJ(10),CKK(10),SLL(50),PQQ(10),CK(10)
0004 DOUBLE PRECISION DXK(100)
0005 DOUBLE PRECISION CBB(10),ACC(10),BSS(100),CSS(100),GCC(600),
0006 $SSS(50),X,XS,SX,BX,SI,BA,CA,A,AS,AB,CB,AC,BC,SS,B,C,XN,XBAR,
0007 $SD,Z,O,OI,ZJ,ZI,ZH,ZZJ,ZZL,ZZH,XK,XKK,ZEE,P1,P2,ZZ,ZO,ZK1,ZK2
0008 DOUBLE PRECISION SX1(600),SX2(600),XR(20)
0009 DIMENSION HFILE(3),IFMT(20),IBUF(256),IB(272)
0010 INTEGER P,Q,R
0011 DATA SX/600*0.50/,SX2/600*0.50/
0012 DATA SJJ,SKK,SLL,PQQ,CK,DXK/190*0.50/
0013 DATA CBB,ACC,BSS,CSS,SLL,SSS/870*0.50/
0014 DATA XS,SX,BX,SI,BA,CA,A,AS,AB,AC,BC,SS,B,C/14*0.50/
0015 WRITE(1,4400)
0016 4400 FORMAT ('RBF-P,Q,R OR AV33 ',
0017 $/,5X,'THREE WAY ANOVA WITH REPEATED MEASURES ON ALL ',
0018 $' FACTORS. ')
0019 WRITE(1,4401)
0020 4401 FORMAT('ENTER NAME OF DATA FILE')
0021 READ(1,7) HFILE
0022 7 FORMAT(3A2)
0023 WRITE(1,4402)
0024 4402 FORMAT ( ' ENTER FORMAT OF DATA ' )
0025 READ(1,6) IFMT
0026 6 FORMAT(20A2)
0027 CALL OPEN(IB,IER,HFILE,3,0,-2,256)
0028 IF(IER.LT.0) GO TO 999
0029 WRITE(1,4403)
0030 4403 FORMAT ( ' LEVELS OF A ' )
0031 READ(1,*) P
0032 WRITE(1,4404)
0033 4404 FORMAT ( ' LEVELS OF B ' )
0034 READ(1,*) Q
0035 WRITE(1,4405)
0036 4405 FORMAT ( ' LEVELS OF C ' )
0037 READ(1,*) R
0038 WRITE(1,4406)
0039 4406 FORMAT ( ' SS/CELL ' )
0040 READ(1,*) N
0041 O=Q*R*N
0042 WRITE(1,224)
0043 224 FORMAT('ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER')
0044 READ(1,*) IUNIT
0045 WRITE(1,223)
0046 223 FORMAT('DO YOU WISH A PRINTOUT OF RAW DATA (1=YES, 0=NO)')
0047 READ(1,*) IPTO
0048 DO 90 I=1,P
0049 DO 440 L=1,N
0050 DO 520 J=1,Q
0051 CALL READF(IB,IER,IBUF)
0052 CALL CODE

```

```

0053 READ(1BUF,1FMT) (XR(I3),I3=1,R)
0054 IF(IPT0.EQ.1) WRITE(1UNIT,1FMT) (XR(I2),I2=1,R)
0055 DO 695 K=1,R
0056 X=XR(K)
0057 III=(I-1)*Q*R + (J-1)*R +K
0058 SX2(III)=SX2(III) + X*X
0059 SX1(III)=SX1(III)+X
0060 XS=XS + X*X
0061 SX=SX + X
0062 BX=BX+X
0063 SI=SI+X
0064 SJJ(J)=SJJ(J)+X
0065 SKK(K)=SKK(K)+X
0066 SLL(L)=SLL(L)+X
0067 PQQ(J)=PQQ(J)+X
0068 CK(K)=CK(K)+X
0069 II=J+Q*(K-1)
0070 DXX(II)=DXX(II)+X
0071 CBB(II)=CBB(II)+X
0072 ACC(K)=ACC(K)+X
0073 II=J+Q*(L-1)
0074 BSS(II)=BSS(II)+X
0075 II=K+R*(L-1)
0076 CSS(II)=CSS(II)+X
0077 M=M+1
0078 SCC(M)=SCC(M)+X
0079 695 SSS(L)=SSS(L)+X
0080 BA=BA+BX*BX/R
0081 520 BX=0
0082 DO 440 K=1,R
0083 CA=CA+CK(K)*CK(K)/Q
0084 440 CK(K)=0
0085 A=A+SI*SI/(Q*R*M)
0086 SI=0
0087 DO 390 L=1,N
0088 AS=AS+SLL(L)*SLL(L)/(Q*R)
0089 390 SLL(L)=0
0090 DO 930 J=1,Q
0091 AB=AB+PQQ(J)*PQQ(J)/(R*M)
0092 PQQ(J)=0
0093 DO 930 K=1,R
0094 II=J+Q*(K-1)
0095 CB=CB+CBB(II)*CBB(II)/M
0096 930 CBB(II)=0
0097 DO 820 K=1,R
0098 AC=AC+ACC(K)*ACC(K)/(M*Q)
0099 ACC(K)=0
0100 820 M=0
0101 90 CONTINUE
0102 DO 1120 J=1,Q
0103 DO 1120 K=1,R
0104 II=J+Q*(K-1)
0105 BC=BC+DXX(II)*DXX(II)/(P*M)
0106 1120 CONTINUE

```

```

0107      DO 1040 L=1,N
0108      SS=SS+SSS(L)*SSS(L)/(P*Q*R)
0109 1040   CONTINUE
0110      DO 1240 J=1,Q
0111      B=B+SJJ(J)*SJJ(J)/(P*R*N)
0112 1240   CONTINUE
0113      DO 1250 K=1,R
0114      C=C+SJK(K)*SJK(K)/(P*Q*N)
0115 1250   CONTINUE
0116      X=SX*SX/(P*Q*R*N)
0117      WRITE(IUNIT,225)
0118 225    FORMAT(//,,"0 CELL",5X,"N",11X,"SUMX",7X,"SUMX2",7X,"MEAN",
0119          17X,"SD",/)
0120      XN=N
0121      DO 226 I=1,P
0122      DO 226 J=1,Q
0123      DO 226 K=1,R
0124      III=(I-1)*Q*R +(J-1)*R +K
0125      XBAR=SX1(III)/XN
0126      SD=DSQRT((SX2(III)-(SX1(III)*SX1(III))/XN)/(XN-1.))
0127      WRITE(IUNIT,227) I,J,K,N,SX1(III),SX2(III),XBAR,SD
0128 227    FORMAT(3I2,3X,14,3X,4(1X,F10.3))
0129 226    CONTINUE
0130      WRITE(IUNIT,2011)
0131 2011   FORMAT(1X,//,"
0132          ///,1X,"SOURCE          SS          DF          NS          F",
0133          112X,"P(F)",/)
0134      Z=XS+X-SS-CB
0135      O=(N-1)*(P*Q*R-1)
0136      O1=O
0137      ZJ=A-X
0138      K=P-1
0139      ZI=Z/O
0140      ZL=ZJ/K
0141      ZM=ZL/ZI
0142      ZZJ=B-X
0143      KK=Q-1
0144      ZZL=ZZJ/KK
0145      ZZN=ZZL/ZI
0146      XK=K
0147      XKK=KK
0148      CALL FPROB(ZM,XK,O1,ZEE,P1)
0149      CALL FPROB(ZM,XKK,O1,ZEE,P2)
0150      WRITE(IUNIT,3110)ZJ,K,ZL,ZM,P1,ZZJ,KK,ZZL,ZZM,P2
0151 3110   FORMAT(1X," A          ",F8.3,5X,13,2(5X,F8.3),3X,F10.6,
0152          //," B          ",F8.3,5X,13,2(5X,F8.3),3X,F10.6)
0153      ZJ=C-X
0154      K=R-1
0155      ZL=ZJ/K
0156      ZM=ZL/ZI
0157      ZZJ=AB+X-A-B
0158      KK=(P-1)*(Q-1)
0159      ZZL=ZZJ/KK
0160      ZZN=ZZL/ZI

```

```

0161      XK=K
0162      XKK=KK
0163      CALL FPROB(ZH,XK,01,ZEE,P1)
0164      CALL FPROB(ZZH,XKK,01,ZEE,P2)
0165      WRITE(IUNIT,2310)ZJ,K,ZL,ZH,P1,ZZJ,KK,ZZL,ZZH,P2
0166 2310  FORMAT(1X," C",F8.3,5X,13,2(5X,F8.3),3X,F10.6,
0167        // " AB",F8.3,5X,13,2(5X,F8.3),3X,F10.6)
0168      ZJ=AC+X-A-C
0169      K=(P-1)*(R-1)
0170      ZL=ZJ/K
0171      ZH=ZI/ZI
0172      ZZJ=BC+X-B-C
0173      KK=(Q-1)*(R-1)
0174      ZZL=ZZJ/KK
0175      ZZH=ZZL/ZI
0176      ZK1=K
0177      ZK2=KK
0178      CALL FPROB(ZH,ZK1,01,ZEE,P1)
0179      CALL FPROB(ZZH,ZK2,01,ZEE,P2)
0180      WRITE(IUNIT,2510)ZJ,K,ZL,ZH,P1,ZZJ,KK,ZZL,ZZH,P2
0181 2510  FORMAT(1X," AC",F8.3,5X,13,2(5X,F8.3),3X,F10.6,
0182        // " BC",F8.3,5X,13,2(5X,F8.3),3X,F10.6)
0183      ZJ=CB+A+B-C-X-AB-AC-BC
0184      K=K*(P-1)
0185      ZL=ZJ/K
0186      ZH=ZL/ZI
0187      ZZ=XS-X
0188      ZO=N*P*Q*R-1
0189      XK=K
0190      CALL FPROB(ZH,XK,01,ZEE,P1)
0191      WRITE(IUNIT,2710)ZJ,K,ZL,ZH,P1,Z,ZI,ZZ,ZO
0192 2710  FORMAT(1X," ABC",F8.3,5X,13,2(5X,F8.3),3X,F10.6,
0193        // " RESIDUAL",F10.3,F8.0,5X,F8.3,
0194        // " TOTAL",F8.3,1X,F8.0,5X,F8.3,/)
0195      CALL CLOSE(IB,IER)
0196      GO TO 987
0197 999  WRITE(1,4408)
0198 4408  FORMAT ("ERROR ON CALL OPEN STATEMENT")
0199 987  END
0200  END$

```

AC10 (CRAC) (One-way Analysis of Covariance)

Purpose:

This program performs a one-way analysis of covariance for one covariate without replication.

Mathematical Model:

The model of this design is:

$$Y_{ij}(\text{adj}) = Y_{ij} - B'_w (X_{ij} - \bar{X}_{..}) = u + B_j + \epsilon_{i(j)},$$

where:

Y_{ij} = unadjusted criterion measure

B'_w = common population linear regression coefficient for treatment levels

X_{ij} = covariate measure for subject i in treatment population j

The hypothesis to be tested is:

$$H_0: B_j = 0 \text{ for all } j$$

The fixed effect model (Model 1) was assumed in the deviation of the expected values of the mean squares.

Layout of Design:

b_1		b_2		b_k	
Y	X	Y	X	Y	X
S_1		S_2		S_j	

1. There are k levels of treatment B .
2. Subjects are randomly assigned with each subject designated to receive only one level.
3. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.

4. The relationship of the dependent variable and the covariate must be linear.

User Considerations and Procedures:

1. A data file must be created in sequential form. For each subject, enter the dependent measure (Y) first, then the covariate (X). (For example, subject one for treatment b_1 , and the covariate is the first record, subject two for treatment b_1 , and the covariate is the second record. Repeat for all subjects in b_1 then index to the next level of B.) A printout of raw data should show two data point per line.
2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of levels of B (maximum 100)
 - b. number of subjects per group (level) (maximum 32767)
 - c. name of data file
 - d. format of data file
5. Printout gives:
 - a. raw data by group (optional)
 - b. for each group: N , S_y , S_y^2 , $\bar{Y}$, SD
 - c. ANOVA source table
 - d. intermediate calculations of the adjusted scores
 - e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependent variable. With analysis of covariance, the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on printout of the data must be used to adjust the means. Computational procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp.465-472.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 465-467. This program uses double precision in all calculations.

RU,AC10
 CRAC-K OR AC10 ANALYSIS OF COVARIANCE
 NOTE: PROGRAM EXPECTS DATA IN ONE SEQUENTIAL FILE
 INDEXING FOR SUBJECTS, FIRST THEN, GROUPS -
 WITH TWO POINTS PER LINE DEPENDENT VARIABLE THEN COVARIATE
 ENTER NAME OF YOUR FILE FROM DATA30 PROGRAM
 #JACOV
 ENTER THE RECORD LENGTH AS IN DA30
 28
 ENTER FORMAT OF DATA
 (2(4X,F10.4))
 HOW MANY GROUPS?
 4
 HOW MANY SUBJECTS/GROUPS?
 8
 ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0
 1
 ENTER 1 FOR CRT DISPLAY, OR 6 FOR LINEPRINTER
 6
 AC10 : STOP 0000
 :

3.0000	42.0000
6.0000	57.0000
3.0000	33.0000
3.0000	47.0000
1.0000	32.0000
2.0000	35.0000
2.0000	33.0000
2.0000	39.0000

4.0000	47.0000
5.0000	49.0000
4.0000	42.0000
3.0000	41.0000
2.0000	38.0000
3.0000	43.0000
4.0000	48.0000
3.0000	45.0000

7.0000	61.0000
3.0000	65.0000
7.0000	64.0000
6.0000	56.0000
5.0000	52.0000
6.0000	58.0000
5.0000	53.0000
6.0000	54.0000

7.0000	65.0000
8.0000	74.0000
9.0000	80.0000
8.0000	73.0000
10.0000	85.0000
10.0000	82.0000
9.0000	78.0000
11.0000	89.0000

Y-TERMS (DEP. VAR.)

(BS)	1160.000
(Y)	924.500
(B)	1119.000

X-TERMS (COVAR.)

(BS)	105202.000
(X)	96800.000
(B)	103997.250

XY-TERMS

(BS)	10840.000
(XY)	9460.000
(B)	10637.750

CELL	N	SUMX	SUMX2	MEAN	SD
1	8	22.000	76.000	2.750	1.488
2	8	28.000	104.000	3.500	.926
3	8	50.000	320.000	6.250	1.035
4	8	72.000	660.000	9.000	1.309

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
TOTAL	8.840	30.			
BETWEEN GRPS	1.793	3.00	.598	2.290	.100
WITHIN GRPS	7.047	27.	.261		

CORRELATION COEFFICIENTS

BETWEEN GRPS	.995
WITHIN GRPS	.910
TOTAL	.981

*AC10 T=00003 IS ON CR00002 USING 00019 BLKS R=0000

```
0001 FTH4
0002 PROGRAM AC10
0003 DIMENSION NFILE(3), IFMT(20)
0004 DOUBLE PRECISION X,Y,SX,SY,YS,XS,GX,GY,XB,YB,GG,X2,SS,C,D,ZI
0005 DOUBLE PRECISION ZJ,ZN,ZNJ,BN,BNK1,BN2,QN,XN,Y2,KY
0006 DIMENSION IB(272),IBUF(256)
0007 DOUBLE PRECISION SUMX(100),SUMX2(100)
0008 SX=0.
0009 SY=0.
0010 XY=0.
0011 YS=0.
0012 XS=0.
0013 GX=0.
0014 XB=0.
0015 YB=0.
0016 GG=0.
0017 WRITE(1,4400)
0018 4400 FORMAT ( "CRAC-K OR AC10 ANALYSIS OF COVARIANCE " ,
0019 $/,5X,"NOTE: PROGRAM EXPECTS DATA IN ONE SEQUENTIAL FILE",
0020 $/,11X,"INDEXING FOR SUBJECTS , FIRST THEN, GROUPS - ",/,
0021 $,11X,"WITH TWO POINTS PER LINE DEPENDENT VARIABLE THEN " ,
0022 $,"COVARIATE. ",11X," MAX 100 GROUPS")
0023 WRITE(1,4401)
0024 4401 FORMAT ( "ENTER NAME OF YOUR FILE FROM DATA30 PROGRAM" )
0025 READ(1,99)NFILE
0026 99 FORMAT(3A2)
0027 IDCBS=256
0028 CALL OPEN(1B,IER,NFILE,3,0,-2,IDCBS)
0029 IF( IER.GE.0) GO TO 689
0030 WRITE(1,345) NFILE,IER
0031 345 FORMAT(5X,3A2," FAILED TO OPEN , IER = ",I5)
0032 STOP 345
0033 689 WRITE(1,4402)
0034 4402 FORMAT ( "ENTER FORMAT OF DATA" )
0035 READ(1,6)IFMT
0036 6 FORMAT(20A2)
0037 WRITE(1,4403)
0038 4403 FORMAT ( " HOW MANY GROUPS? " )
0039 READ(1,*) K
0040 WRITE(1,4404)
0041 4404 FORMAT ( " HOW MANY SUBJECTS/GROUP? " )
0042 READ(1,*) N
0043 BN=N*K
0044 XN=N
0045 WRITE(1,9001)
0046 9001 FORMAT("ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0")
0047 READ(1,*) IPT0
0048 WRITE(1,1234)
0049 1234 FORMAT("ENTER 1 FOR CRT DISPLAY, OR 6 FOR LINEPRINTER")
0050 READ(1,*) IUNIT
0051 DO230 I=1,K
```

```

0052      IF(IPTO.EQ.1) WRITE(IUNIT,903)
0053 903   FORMAT(//)
0054      DO330 J=1,N
0055      CALL READF(IB,IER,IBUF)
0056      CALL CODE
0057      READ(IBUF,IFMT)Y,X
0058      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
0059      SX=SX+X
0060      SUMX(I)=SUMX(I)+Y
0061      SUMX2(I)=SUMX2(I)+Y*Y
0062      SY=SY+Y
0063      XY=XY+X*Y
0064      YS=YS+Y*Y
0065      XS=XS+X*X
0066      GX=GX+X
0067 330   GY=GY+Y
0068 3109  FORMAT(//)
0069      XB=XB+GX*GX/XN
0070      YB=YB+GY*GY/XN
0071      GG=GG+GX*GY/XN
0072      Y=GY/XN
0073      X=GX/XN
0074      GX=0
0075      GY=0
0076 230   CONTINUE
0077      Y2=SY*SY/BN
0078      X2=SX*SX/BN
0079      SS=SY*SY/BN
0080      WRITE(IUNIT,600)
0081 600   FORMAT(1X,//)
0082      WRITE(IUNIT,161)YS,Y2
0083 161   FORMAT(1X,"Y-TERMS(DEP. VAR.)",//,"(BS)",F12.3,/,1X,"(Y)",2X,
0084      $F12.3)
0085      WRITE(IUNIT,171)YB
0086 171   FORMAT(" (B)",2X,F12.3,/,/,1X,"X-TERMS(COVAR.)")
0087      WRITE(IUNIT,1711)XS,X2
0088 1711  FORMAT(1X,"(BS)",1X,F12.3,/,/,1X,"(X)",2X,F12.3)
0089      WRITE(IUNIT,181)XB,XY,SS,GG
0090 181   FORMAT(" (B)",2X,F12.3,/,/,1X,"XY-TERMS",/,1X,"(BS)",1X,F12.3,/,
0091      $1X,"(XY)",1X,F12.3,/,/,1X,"(B)",1X,F12.3)
0092      WRITE(IUNIT,453)
0093 453   FORMAT(/////,"0 CELL",4X,"N",7X,"SUMX",6X,"SUMX2",9X,"MEAN",
0094      $110X,"SD",//)
0095      DO228 I=1,K
0096      XB1=SUMX(I)/XN
0097      SD1=DSQRT((SUMX2(I)-(SUMX(I)*SUMX(I))/XN)/(XN-1))
0098      WRITE(IUNIT,229) I,N,SUMX(I),SUMX2(I),XB1,SD1
0099 229   FORMAT(1X,I3,3X,I3,4(3X,F10.3))
0100 228   CONTINUE
0101      C=YS-Y2-(XY-SS)*(XY-SS)/(XS-X2)
0102      D=YS-YB-(XY-GG)*(XY-GG)/(XS-XB)
0103      ZI=C-D
0104      ZJ=D/(BN-K-1)
0105      ZN=ZI/(K-1)
0106      WRITE(IUNIT,531)

```

```

0107 531 FORMAT(1X,/,17X,"SOURCE TABLE")
0108 WRITE(IUNIT,536)
0109 536 FORMAT(1X,/,4X,"SOURCE",11X,"SS",8X,"DF",9X,"MS",9X,"F",9X,
0110 1"P(F)")
0111 K1=K-1
0112 ZNJ=ZN/ZJ
0113 BNK1=BN-K-1
0114 BN2=BN-2
0115 WRITE(IUNIT,700)C,BN2
0116 700 FORMAT(1X,"TOTAL",7X,F12.3,5X,F4.0)
0117 DF1=K1
0118 DF2=BNK1
0119 F=ZNJ
0120 CALL FPROB(F,DF1,DF2,Z3,PF1)
0121 WRITE(IUNIT,541)Z1,K1,ZN,ZNJ,PF1
0122 541 FORMAT(/,1X,"BETWEEN GRPS",F12.3,4X,F4.3,3(5X,F7.3),/)
0123 WRITE(IUNIT,551)D,BNK1,ZJ
0124 551 FORMAT(1X,"WITHIN GRPS",1X,F12.3,5X,F4.0,4X,F7.3)
0125 C=(XY-SS)/DSQRT((XS-X2)*(YS-Y2))
0126 D=(GG-SS)/DSQRT((XB-X2)*(YB-Y2))
0127 QN=(XY-GG)/DSQRT((XS-XB)*(YS-YB))
0128 WRITE(IUNIT,571)
0129 571 FORMAT(1X,/,," CORRELATION COEFFICIENTS ")
0130 WRITE(IUNIT,581)D,QN
0131 581 FORMAT(2X,/,1X,"BETWEEN GRPS",F9.3,/,1X,"WITHIN GRPS",1X,F9.3)
0132 WRITE(IUNIT,5811)C
0133 5811 FORMAT(4X,"TOTAL ",2X,F9.3,/)
0134 CALL CLOSE(18,IER)
0135 STOP
0136 END
0137 END*

```

AC11 (RBAC-K) (One-way Analysis of Covariance, Repeated Measures)

Purpose:

This program performs a one-way analysis of covariance for one covariate with replication either by using matched subjects or repeated measures.

Mathematical Model:

The model for this design is:

$$Y_{ij}(\text{adj}) = Y_{ij} - B'_w(X_{ij} - \bar{X}_{..}) = u + B_j + \pi_i + E_{ij}$$

where:

Y_{ij} = readjusted criterion measure

B'_w = common population linear regression coefficient for treatment levels

The hypothesis to be tested is:

$$H_0: B_j = 0 \text{ for all } j$$

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

b_1		b_2		b_k	
Y	X	Y	X	Y	X
s_1		s_1		s_1	

S represents a set of subjects

1. There are k levels of treatment B.
2. Subjects are assigned to a treatment so that the variability within a treatment is less than the variability among treatments. Homogeneity within treatments may be achieved by using a subject as his own control or match subjects on the basis of a variable that correlates with the dependent variable.

3. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.
4. The relationship of the dependent variable and the covariate is linear.
5. For repeated measures, the dependent measure for each subject is paired with a unique covariate measure. The covariate cannot be identical for all measures, e.g., age of a subject.

User Considerations and Procedures:

1. A data file must be created in sequential form, with the dependent measure (Y) first, then the covariate (X). (For example, subject one for treatment b_1 and the covariate is the first record, subject two for treatment b_1 and the covariate is the second record. Follow this procedure for all subjects in b_1 then index to the next level of B.) A printout of raw data shows two data points per line.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of levels of B (maximum 100)
 - b. number of subjects per group (level) (maximum 32767)
 - c. name of data file
 - d. format of data file
 - e. correlation coefficients
5. Printout gives:
 - a. raw data by group (optional)
 - b. for each group: N , Σy , Σy^2 , $\bar{Y}$, SD

- c. ANOVA source table
- d. intermediate calculations of the adjusted scores
- e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependent variable. With analysis of covariance, the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on the printout of the data must be used to adjust the means. Computational procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968. Pp. 475-477.

Test Data:

This program was tested by comparing the results of the AC11 program to results obtained from a similar PDP 8/e Analysis of Covariance program. The program uses double precision in all calculations.

RU,AC11
 AC11 OR
 REAC-K ONE-WAY ANALYSIS OF COVARIANCE FOR
 REPEATED MEASURES. DATA INPUT READ SEQUENCE
 INDEX FOR SUBJECTS, THEN FOR WITHIN FACTOR. ENTER THE
 DEPENDENT VARIABLE, THEN THE COVARIATE
 ENTER NAME OF THE DATA FILE
 #JRBAC
 ENTER FORMAT OF DATA
 (2(2X,F8.4))
 HOW MANY TREATMENTS?
 4
 HOW MANY SUBJECTS?
 6
 ENTER THE RECORD LENGTH AS IN DA30
 20
 ENTER 1 FOR RAW DATA PRINTOUT (1=YES)
 1
 ENTER 1 FOR CRT PRINTOUT, 6 FOR LPTR
 6
 AC11 : STOP 0000
 :

202.0000	28.0000		
145.0000	23.0000		
188.0000	27.0000		
201.0000	24.0000		
202.0000	30.0000		
228.0000	30.0000		
MEAN-Y	194.333	MEAN-X	27.000
165.0000	22.0000		
201.0000	26.0000		
185.0000	24.0000		
231.0000	28.0000		
178.0000	26.0000		
221.0000	25.0000		
MEAN-Y	196.833	MEAN-X	25.167
191.0000	27.0000		
203.0000	28.0000		
185.0000	27.0000		
238.0000	30.0000		
198.0000	26.0000		
207.0000	27.0000		
MEAN-Y	203.667	MEAN-X	27.500
134.0000	19.0000		
180.0000	24.0000		
220.0000	28.0000		
261.0000	30.0000		
226.0000	29.0000		
204.0000	24.0000		
MEAN-Y	204.167	MEAN-X	25.667

Y-TERMS (DEP. VAR.)

(BS)	976280.000
(Y)	957601.500
(B)	958037.667
(S)	967091.500

X-TERMS (COVAR.)

(BS)	16824.000
(Y)	16642.667
(B)	16664.333
(S)	16688.500

Y-TERMS

(BS)	127727.000
(XY)	126242.000
(B)	126250.500
(S)	126801.250

CELL	N	SUMX	SUMX2	MEAN	SD
1	6	1166.000	230362.000	194.333	27.457
2	6	1181.000	235737.000	196.833	25.600
3	6	1222.000	250612.000	203.667	18.608
4	6	1225.000	259569.000	204.167	43.508

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
TREATMENT	1502.394	3.	500.798	5.150	.0132
BLOCKS	3227.275	5.	645.455	6.638	.0026
RESIDUAL	1361.286	14.	97.235		
TOTAL	6517.333	22.			

CORRELATION COEFFECENTS

TREATMENTS	.087
BLOCKS	.848
RESIDUAL	.919
TOTAL	.807

*AC11 T=0000 IS ON CR00002 USING 00022 BLKS R=0000

```
0001 FTH4
0002 PROGRAM AC11
0003 REAL X1,K1X1
0004 DOUBLE PRECISION S1A,S2A,X,Y,SX,SY,YS,XS,GX,X2,GY
0005 DOUBLE PRECISION XB,YB,GG,ZK,S1,S2,SS,Y2,C,ZJ,ZI,D,ZI1,ZH
0006 DOUBLE PRECISION GXB,XB,SD,X1,X3,XN
0007 DOUBLE PRECISION S1A(100),S2A(100),X1(100),X3(100)
0008 DIMENSION NFILE(3),IFMT(20),IB(272),IBUF(256)
0009 WRITE(1,4399)
0010 4399 FORMAT(" AC11 OR ",/,
0011 C" RBAC-K ONE-WAY ANALYSIS OF COVARIANCE FOR ",/,
0012 $" REPEATED MEASURES. DATA INPUT READ SEQUENCE",/,
0013 %10X,"INDEX FOR SUBJECTS, THEN FOR WITHIN FACTOR. ENTER THE",/,
0014 &10X,"DEPENDENT VARIABLE, THEN THE COVARIATE")
0015 WRITE(1,987)
0016 987 FORMAT("ENTER NAME OF THE DATA FILE")
0017 READ(1,16)NFILE
0018 16 FORMAT(3A2)
0019 WRITE(1,4401)
0020 4401 FORMAT ( " ENTER FORMAT OF DATA " )
0021 READ(1,6)IFMT
0022 6 FORMAT(20A2)
0023 WRITE(1,4402)
0024 4402 FORMAT ( " HOW MANY TREATMENTS? " )
0025 READ(1,*) K
0026 WRITE(1,4403)
0027 4403 FORMAT ( " HOW MANY SUBJECTS? " )
0028 READ(1,*) N
0029 IDCBS=256
0030 CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
0031 IF (IER.LT.0) GO TO 999
0032 WRITE(1,154)
0033 154 FORMAT("ENTER 1 FOR RAW DATA PRINTOUT(1=YES)")
0034 READ(1,*) IPTO
0035 WRITE(1,912)
0036 912 FORMAT("ENTER 1 FOR CRT PRINTOUT, 6 FOR LPTR")
0037 READ(1,*) IUNIT
0038 BN=N*K
0039 XH=N
0040 DO 230 I=1,K
0041 DO 330 J=1,N
0042 CALL READF(IB,IER,IBUF)
0043 CALL CODE
0044 READ(IBUF,IFMT) Y,X
0045 IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
0046 SX=SX+X
0047 X1(I)=X1(I)+Y
0048 X3(I)=X3(I)+Y*Y
0049 SY=SY+Y
```

```

0050      XY=XY+X*Y
0051      YS=YS+Y*Y
0052      XS=XS+X*X
0053      GX=GX+X
0054      GY=GY+Y
0055      S1A(J)=S1A(J)+Y
0056 330    S2A(J)=S2A(J)+X
0057      XB=XB+GX*GX/XN
0058      YB=YB+GY*GY/XN
0059      GG=GG+GX*GY/M
0060      GY=GY/M
0061      GX=GX/M
0062      WRITE(IUNIT,231)GY,GX
0063 231    FORMAT(1X," MEAN-Y ",F10.3,4X," MEAN-X ",F10.3)
0064      GX=0
0065      GY=0
0066 230    CONTINUE
0067      DO 190 J=1,M
0068      ZK=K
0069      S1=S1+S1A(J)*S1A(J)/ZK
0070      S2=S2+S2A(J)*S2A(J)/ZK
0071 190    S3=S3+S1A(J)*S2A(J)/ZK
0072      Y2=SY*SY/BN
0073      X2= SX* SX/BN
0074      SS=SY* SX/BN
0075      WRITE(IUNIT,600)
0076 600    FORMAT(1X,/)
0077      WRITE(IUNIT,161)YS,Y2
0078 161    FORMAT(1X,"Y-TERMS(DEP. VAR.) ",/, " (BS) ",F12.3,/,1X,"(Y)",2X,
0079      1F12.3)
0080      WRITE(IUNIT,171)YB,S1
0081 171    FORMAT(" (B)",2X,F12.3,/, " (S)",2X,F12.3,/,1X,
0082      C"X-TERMS(COVAR.)")
0083      WRITE(IUNIT,1711)XS,X2
0084 1711    FORMAT(1X,"(SS)",1X,F12.3,/,1X,"(X)",2X,F12.3)
0085      WRITE(IUNIT,181)XB,S2,XY,SS,GG
0086 181    FORMAT(" (B)",2X,F12.3,/, " (S)",2X,F12.3,/, "XY-TERMS",/,
0087      X" (BS)",1X, F12.3,/,1X,"(XY)",1X,F12.3,/,1X,"(B) ",1X,F12.3)
0088      WRITE(IUNIT,1811)S3
0089 1811    FORMAT(" (S)",2X,F12.3)
0090      C=YS-Y2-(XY-SS)*(XY-SS)/(XS-X2)
0091      ZJ=YS+Y2-YB-S1
0092      X=XS+X2-XB-S2
0093      ZI=XY+SS-GG-S3
0094      D=ZJ-ZI*ZI/X
0095      Y=S1-Y2+ZJ-(S3-SS+ZI)*(S3-SS+ZI)/(S2-X2+X)-D
0096      ZI1=YB-Y2+ZJ-(GG-SS+ZI)*(GG-SS+ZI)/(XB-X2+X)-D
0097      X=M-1
0098      GY=Y/X
0099      ZJ=D/((K-1)*X-1)
0100      ZN=ZI1/(K-1)
0101      WRITE(IUNIT,703)
0102 703    FORMAT(////,"0 CELL",4X,"M",7X,"SUMX",6X,"SUMX2",6X,"MEAN",
0103      111X,"SD",/)

```

```

0104      XM=M
0105      GXB=XB
0106      DO 704 I=1,K
0107      XB=X1(I)/XM
0108      SD=DSQRT((X3(I)-(X1(I)*X1(I))/XM)/(XM-1.))
0109 704    WRITE(IUNIT,709) I,H,X1(I),X3(I),XB,SD
0110 709    FORMAT(2I5,1X,4(3X,F10.3))
0111      WRITE(IUNIT,531)
0112 531    FORMAT(1X,/,17X,"SOURCE TABLE")
0113      GX=GY/ZJ
0114      XB=GXB
0115      K1=K-1
0116      K1X1=(K-1)*X-1.
0117      ZNJ=ZN/ZJ
0118      CALL FPROB(ZNJ,K1,K1X1,ZT1,PF1)
0119      DF1=X
0120      GX1=GX
0121      CALL FPROB(GX1,DF1,K1X1,ZT2,PF2)
0122      WRITE(IUNIT,536)
0123 536    FORMAT(1X,/,4X,"SOURCE",11X,"SS",8X,"DF",9X,"MS",9X,"F",
0124          18X,"P(F)",/)
0125      WRITE(IUNIT,541)ZI1,K1,ZH,ZNJ,PF1
0126 541    FORMAT(1X,"TREATMENT",3X,F9.3,F7.0,6X,F7.3,3X,F7.3,3X,F7.4)
0127      WRITE(IUNIT,542)Y,X,GY,GX,PF2
0128 542    FORMAT(1X,"BLOCKS",2X,F9.3,1X,F7.0,5X,F7.3,3X,F7.3,
0129          13X,F7.4)
0130  C      RESIDUAL
0131      K1X1=(K-1)*X-1
0132      WRITE(IUNIT,545)D,K1X1,ZJ
0133 545    FORMAT(1X,"RESIDUAL",2X,F9.3,F7.0,4X,F9.3)
0134      BN2=BN-2
0135      WRITE(IUNIT,551)C,BN2
0136 551    FORMAT(1X,"TOTAL",8X,F12.3,4X,F10.0)
0137      X=(S3-SS)/DSQRT((S1-Y2)*(S2-X2))
0138      C=(XY-SS)/DSQRT((XS-X2)*(YS-Y2))
0139      D=(GG-SS)/DSQRT((XB-X2)*(YB-Y2))
0140      ZH=(XY+SS-GG-S3)/DSQRT((YS+Y2-YB-S1)*(XS-X2-XB-S2))
0141      WRITE(IUNIT,581)D
0142 581    FORMAT(1X,/,1X,"CORRELATION COEFFECIENTS",/,,"TREATMENTS",2X,
0143          1F5.3)
0144      WRITE(IUNIT,582)X,ZH,C
0145 582    FORMAT("BLOCKS",6X,F5.3,/,,"RESIDUAL",2X,F5.3,/,,"TOTAL",
0146          24X,F5.3)
0147      CALL CLOSE(IB,IER)
0148      STOP
0149 999    WRITE(1,4408)
0150 4408   FORMAT("ERROR ON CALL OPEN STATEMENT")
0151      STOP
0152      END
0153      ENDS

```

AC20 (CRFAC-P,Q) (Two-way Analysis of Covariance)

Purpose:

This program performs a two-way analysis of covariance for one covariate without replication.

Mathematical Model:

The model of this design is:

$$Y_{ijm}(\text{adj}) = Y_{ijm} - B'_w + (X_{ijm} - \bar{X}...) = u + A_i + B_j + AB_{ij} + E_m(ij)$$

where:

Y_{ij} = unadjusted criterion measure

B'_w = common population linear regression coefficient for treatment levels

X_{ij} = covariate measure for subject i in treatment population j

The hypotheses to be tested are:

$H_0: A_i = 0$ for all i

$H_0: B_j = 0$ for all j

$H_0: AB_{ij} = 0$ for all ij

The fixed effect model (Model 1) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A ₁		A ₂		A ₃	
B ₁	B ₂	B ₁	B ₂	B ₁	B ₂
X Y	X Y	X Y	X Y	X Y	X Y
S ₁	S ₂	S ₃	S ₄	S ₅	S ₆

S represents a set of subjects

1. There are two Factors (A,B) with p and q levels of treatments, respectively. The experiment consists of pq treatment combinations. The above example includes three levels of Factor A, two levels of Factor B.

2. Subjects are randomly assigned to the pq treatment combinations, with each subject receiving only one combination.
3. There should be more than one subject per pq treatment combination.
4. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.
5. The relationship of the dependent variable and the covariate is linear.

User Considerations and Procedures:

1. A data file must be created in sequential form with the dependent variable (Y) first, then the covariate (X). On read, indexing for subjects comes first, then for Factor B, and finally Factor A. (For example, first record is subject one for treatment and covariate of ab_{11} , second record is subject two for treatment and covariate of ab_{11} ; continue for all subjects in treatment ab_{11} . Next, enter all subjects for treatment ab_{12} ; repeat for ab_{1q} . Then enter data for ab_{21} . . . , the final record would be subject n for treatment ab_{pq} .) A printout of the raw data would show two data points per line.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of levels of Factor A (see comments)
 - b. number of levels of Factor B (see comments)
 - c. number of subjects per AB cell (maximum 32767) (see comments)
 - d. name of the data file
 - e. format of data file

5. Printout gives:

- a. raw data by group (optional)
- b. for each group: N , Σy , Σy^2 , $\bar{y}$, SD
- c. ANOVA source table
- d. intermediate calculations of the adjusted scores
- e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependent variable. With analysis of the covariance the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on the printout of the data must be used to adjust the means. Computation procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 479-482.

This program has the following restrictions:

1. The number of subjects per AB treatment combinations should be equal.
2. There cannot be more than 400 treatment combinations ($p \cdot q \leq 400$).

Test Data:

This program was tested by comparing the results of the AC20 program to results obtained from a similar PDP 8/e Analysis of Covariance program. The program uses double precision in all calculations.

RU,AC20
 AC20 OR
 CRFAC-P,Q ANALYSIS OF COVARIANCE ON TWO FACTORS
 WITH NO REPEATED MEASURES. ON INPUT READ SEQUENCE, INDEX
 FOR SUBJECTS FIRST, THEN FACTOR B AND FINALLY FACTOR A.
 PROGRAM EXPECTS 2 DATA POINTS PER LINE - DEPENDENT VARIABLE,
 THEN THE COVARIATE
 ENTER DATA FILE NAME
 #JCRFA
 ENTER FORMAT OF DATA FILE
 (2(2X,F8.4))
 ENTER THE RECORD LENGTH AS IN DA30
 20
 HOW MANY LEVELS OF A?
 2
 HOW MANY LEVELS OF B?
 3
 HOW MANY LEVELS OF SS/CELL?
 5
 ENTER 1 FOR PRINTOUT OF RAW DATA, 0 IF NOT
 1
 ENTER 1 FOR CRT PRINTOUT, OR 6 FOR LPTR
 6
 AC20 : STOP 0000
 :

Y	X
95.0000	40.0000
80.0000	35.0000
95.0000	40.0000
105.0000	50.0000
100.0000	45.0000

85.0000	30.0000
100.0000	40.0000
85.0000	45.0000
90.0000	40.0000
90.0000	40.0000

90.0000	50.0000
85.0000	40.0000
90.0000	40.0000
80.0000	30.0000
85.0000	40.0000

100.0000	50.0000
95.0000	30.0000
95.0000	35.0000
110.0000	45.0000
88.0000	30.0000

100.0000	50.0000
90.0000	30.0000
95.0000	40.0000
90.0000	45.0000
95.0000	40.0000

95.0000	45.0000
85.0000	30.0000
75.0000	25.0000
105.0000	50.0000
85.0000	35.0000

Y-TERMS (DEPENDENT VARIABLE)

(A)	253628.9333	(B)	253939.4000	(AB)	254018.8000
(ABS)	255444.0000	(Y)	253552.1333		

X-TERMS (COVARIABLE)

(A)	46828.3333	(B)	46827.5000	(AB)	46895.0000
(ABS)	48325.0000	(X)	46807.5000		

XY-TERMS

(A)	108901.0000	(B)	109007.5000	(AB)	108979.0000
(ABS)	110065.0000	(XY)	108941.0000		

CELL	N	SUMX	SUMX2	MEAN	SD
1 1	5	475.000	45475.000	95.000	9.354
1 2	5	450.000	40650.000	90.000	6.124
1 3	5	430.000	37050.000	86.000	4.183
2 1	5	488.000	47894.000	97.600	8.142
2 2	5	470.000	44250.000	94.000	4.183
2 3	5	445.000	40125.000	89.000	11.402

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	147.423	1	147.423	5.64701	.02477
B	292.811	2	146.405	5.60802	.01036
AB	14.412	2	7.206	.27603	.76459
ERROR	600.448	23	26.106		
TOTAL	1059.329	28			

CORRELATION COEFFICIENTS

A	-1.000
B	.873
AB	.992
ERROR	.761
TOTAL	.663

*AC20 T=00004 IS ON CR00002 USING 00027 BLKS R=0211

```

0001 FTH4
0002 PROGRAM AC20
0003 INTEGER P,Q,D
0004 DOUBLE PRECISION BXX(400),X,Y, SX,SY,ZS,YX,XS,SA,AS,SH,SNS,BA,XN
0005 DOUBLE PRECISION AB,ZZ,SNSN,SNM,AX,AY,AZ,ASQN,SAQN,PQN,SZ,BY,
0006 IBX,BZ,BYJPH,BXJPH,C,DD,ZI,ZZ,AYSX,BYSX,BA8X,BYY(400)
0007 DOUBLE PRECISION PQN,QN,PN
0008 DIMENSION IB(272),IBUF(256),NFILE(3),IFMT(20)
0009 DOUBLE PRECISION SUMX(400),SUMX2(400)
0010 DO 897 K=1,400
0011 BXX(K)=0.
0012 897 BYY(K)=0.
0013 WRITE(1,3999)
0014 3999 FORMAT("AC20 OR ",/,
0015 C"CRFAC-P,Q ANALYSIS OF COVARIANCE ON TWO FACTORS",/,
0016 $13X,"WITH NO REPEATED MEASURES. ON INPUT READ SEQUENCE, INDEX",
0017 Z/13X,"FOR SUBJECTS FIRST, THEN FACTOR B AND FINALLY FACTOR A.",
0018 &/,13X,"PROGRAM EXPECTS 2 DATA POINTS PER LINE - DEPENDENT "
0019 B,"VARIABLE",/,13X," THEN THE COVARIATE",/,
0020 C"ENTER DATA FILE NAME")
0021 READ(1,568) NFILE
0022 568 FORMAT(3A2)
0023 WRITE(1,1456)
0024 1456 FORMAT("ENTER FORMAT OF DATA FILE")
0025 READ(1,435) IFMT
0026 IDCBS=256
0027 435 FORMAT(20A2)
0028 CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
0029 IF(IER.GE.0) GO TO 123
0030 WRITE(1,543) NFILE,IER
0031 543 FORMAT(3A2," FAILED TO OPEN , IER = ",I5)
0032 STOP 543
0033 123 WRITE(1,4401)
0034 4401 FORMAT ( " HOW MANY LEVELS OF A? ")
0035 READ(1,*) P
0036 WRITE(1,4402)
0037 4402 FORMAT ( " HOW MANY LEVELS OF B? ")
0038 READ(1,*) Q
0039 WRITE(1,4403)
0040 4403 FORMAT ( " HOW MANY LEVELS OF SS/CELL? ")
0041 READ(1,*) N
0042 WRITE(1,757)
0043 757 FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA , 0 IF NOT")
0044 READ(1,*) IPTO
0045 WRITE(1,987)
0046 987 FORMAT("ENTER 1 FOR CRT PRINTOUT, OR 6 FOR LPTR")
0047 READ(1,*) IUNIT
0048 IF(IPTO.EQ.1) WRITE(IUNIT,109)
0049 109 FORMAT(/,5X,"Y",10X,"X",/)
0050 XN=N

```

```

0051      DO 240 I=1,P
0052      DO 330 J=1,Q
0053      DO 440 K=1,N
0054      CALL READF(IB,IER,IBUF)
0055      CALL CODE
0056      READ(IBUF,IFMT) Y,X
0057      IF (IPT0.EQ.1) WRITE(IUNIT,IFMT) Y,X
0058      SX=SX+X
0059      JJ=(I-1)*Q+J
0060      SUMX(JJ)=SUMX(JJ)+Y
0061      SUMX2(JJ)=SUMX2(JJ)+Y*Y
0062      SY=SY+Y
0063      ZS=ZS+X*Y
0064      YS=YS+Y*Y
0065      XS=XS+X*X
0066      SA=SA+X
0067      AS=AS+Y
0068      SH=SH+X
0069      SHS=SHS+Y
0070      BXX(J)=BXX(J)+X
0071 440    BYY(J)=BYY(J)+Y
0072      IF (IPT0.EQ.1) WRITE(IUNIT,33)
0073 33    FORMAT(//)
0074      BA=BA+SHS*SHS/XN
0075      AB=AB+SH*SH/XN
0076      ZZ=ZZ+SHS*SH/XN
0077      SNSH=SHS/XN
0078      SHN=SH/XN
0079      SH=0
0080 330    SHS=0
0081      QN=Q*N
0082      AX=AX+SA*SA/QN
0083      AY=AY+AS*AS/QN
0084      AZ=AZ+SA*AS/QN
0085      ASQH=AS/QN
0086      SAQH=SA/QN
0087      SA=0
0088 240    AS=0
0089      PQN=P*Q*N
0090      SZ=SY*SX/PQN
0091      SY=SY*SY/PQN
0092      SX=SX*SX/PQN
0093      DO 620 J=1,Q
0094      PH=P*N
0095      BY=BY+BYY(J)*BYY(J)/PH
0096      BX=BX+BXX(J)*BXX(J)/PH
0097      BZ=BZ+BXX(J)*BYY(J)/PH
0098      BYJPH=BYY(J)/PH
0099      BXJPH=BXX(J)/PH
0100 620    CONTINUE
0101      WRITE(IUNIT,171)AY,BY,BA,YS,SY
0102 171    FORMAT(//,1X,"Y-TERMS (DEPENDENT VARIABLE)",
0103      X/," (A) ",F13.4,5X," (B)",F13.4,5X," (AB)",F13.4,
0104      X/," (ABS)",F13.4,5X," (Y)",F13.4,/)

```

```

0105      WRITE(IUNIT,177)AX,BX,AB,XS,SX
0106 177   FORMAT(1X,"X-TERMS (COVARIABLE)",
0107        X/," (A) ",F13.4,5X," (B)",F13.4,5X," (AB)",F13.4,
0108        X/," (ABS)",F13.4,5X," (X)",F13.4,/)
0109      WRITE(IUNIT,183)AZ,BZ,ZZ,ZS,SZ
0110 183   FORMAT(1X,"XY-TERMS",
0111        X/," (A) ",F13.4,5X," (B)",F13.4,6X," (AB)",F13.4,
0112        X/," (ABS)",F13.4,5X," (XY)",F13.4,/)
0113      WRITE(IUNIT,701)
0114 701   FORMAT(////,"O  CELL",4X,"N",7X,"SUMX",6X,"SUMX2",9X,"MEAN",
0115        110X,"SD",/)
0116      DO 704 I=1,P
0117      DO 704 J=1,Q
0118      JJ=(I-1)*Q+J
0119      XB1=SUMX(JJ)/XN
0120      SD1=DSQRT((SUMX2(JJ)-(SUMX(JJ)*SUMX(JJ))/XN)/(XN-1.))
0121 704   WRITE(IUNIT,705) I,J,N,SUMX(JJ),SUMX2(JJ),XB1,SD1
0122 705   FORMAT(1X,2I2,3X,I3,4(3X,F10.3))
0123      SA=(AZ-SZ)/DSQRT((AY-SY)*(AX-SX))
0124      AS=(BZ-SZ)/DSQRT((BY-SY)*(BX-SX))
0125      X=(ZS-SZ)/DSQRT((YS-SY)*(XS-SX))
0126      SH=(ZZ+SZ-AZ-BZ)/DSQRT((BA+SY-AY-BY)*(AB+SX-AX-BX))
0127      SHS=(ZS-ZZ)/DSQRT((YS-BA)*(XS-AB))
0128      Y=(EZ-AZ)/DSQRT((EY-AY)*(EX-AX))
0129      C=SY
0130      DD=SX
0131      ZI=SZ
0132      SY=YS-BA
0133      SX=XS-AB
0134      SZ=ZS-ZZ
0135      BA=BA+C-AY-BY
0136      AB=AB+DD-AX-BX
0137      ZZ=ZZ+ZI-AZ-BZ
0138      AY=AY-C
0139      AX=AX-DD
0140      AZ=AZ-ZI
0141      BY=BY-C
0142      BX=BX-DD
0143      BZ=BZ-ZI
0144      YS=YS-C
0145      XS=XS-DD
0146      ZS=ZS-ZI
0147      C=SY-SZ*SZ/SX
0148      AX=(AY+SY)-(AZ+SZ)*(AZ+SZ)/(AX+SX)-C
0149      BX=(BY+SY)-(BZ+SZ)*(BZ+SZ)/(BX+SX)-C
0150      AB=(BA+SY)-(ZZ+SZ)*(ZZ+SZ)/(AB+SX)-C
0151      XS=YS-ZS*ZS/XS
0152      J=N*P*Q-2
0153      D=P*Q*(N-1)-1
0154      P=P-1
0155      Q=Q-1
0156      I=P*Q
0157      AY=AX/P

```



```

0158      BY=BX/Q
0159      BA=AB/I
0160      SX=C/D
0161      WRITE(IUNIT,545)
0162 545    FORMAT(//,"                      SOURCE TABLE",//)
0163      WRITE(IUNIT,550)
0164 550    FORMAT(1X,"SOURCE",6X,"SS",10X,"DF",12X,"MS",12X,"F",11X,
0165      C"P(F)")
0166      AYSX=AY/SX
0167      DF1=P
0168      DF2=0
0169      F=AYSX
0170      CALL FPROB(F,DF1,DF2,Z,PF1)
0171      WRITE(IUNIT,555)AX,P,AY,AYSX,PF1
0172 555    FORMAT(//," A",5X,F13.3,5X,I3,5X,F13.3,3X,F11.5,3X,F10.5)
0173      BYSX=BY/SX
0174      DF1=Q
0175      F=BYSX
0176      CALL FPROB(F,DF1,DF2,Z,PF2)
0177      WRITE(IUNIT,556)BX,Q,BY,BYSX,PF2
0178 556    FORMAT(" B",5X,F13.3,5X,I3,5X,F13.3,3X,F11.5,3X,F10.5)
0179      BASX=BA/SX
0180      F=BASX
0181      TI=I
0182      CALL FPROB(F,TI,DF2,ZF3,PF3)
0183      WRITE(IUNIT,560)AB,I,BA,BASX,PF3
0184 560    FORMAT(" AB",4X,F13.3,5X,I3,5X,F13.3,3X,F11.5,3X,F10.5)
0185      WRITE(IUNIT,561)C,D,SX
0186 561    FORMAT(1X,"ERROR ",F13.3,5X,I3,5X,F13.3,/)
0187      WRITE(IUNIT,565)XS,J
0188 565    FORMAT(1X,"TOTAL ",F13.3,5X,I3,///)
0189      WRITE(IUNIT,811)
0190 811    FORMAT(1X,"CORRELATION COEFFICIENTS",//)
0191      WRITE(IUNIT,812)SA,AS
0192 812    FORMAT(1X,"A ",F11.3,/,1X,"B ",F11.3)
0193      WRITE(IUNIT,820)SH,SHS
0194 820    FORMAT(1X,"AB ",F11.3,/,1X,"ERROR",F11.3)
0195      WRITE(IUNIT,821)X
0196 821    FORMAT(1X,"TOTAL",F11.3)
0197      CALL CLOSE(IB)
0198      STOP
0199      END
0200      END$

```

AC21B (SPFAC-P,Q) (Two-way Split Plot Analysis of Covariance,
One Repeated Measure)

Purpose:

This program performs a two-way split-plot analysis of covariance for one covariate.

Mathematical Model:

The model for this design is:

$$Y_{ijm(adj)} = Y_{ijm} - B'_b (\bar{X}_{ij.} - \bar{X}...) - B'_w (X_{ijm} - \bar{X}...) = u + A_i - B_j + AB_{ij} + \Sigma_m(i) + B\Sigma_{jm}(i) + E_{ijm}$$

where:

Y_{ij} = unadjusted criterion measure
 B'_b = between subject variation
 B'_w = within subject variation
 X_{ij} = covariate measure for subject i in the treatment population j

The hypotheses to be tested are:

$H_0: A_i = 0$ for all i
 $H_0: B_j = 0$ for all j
 $H_0: AB_{ij} = 0$ for all ij

Layout of Design:

	B ₁ r X	B ₂ Y X	B ₃ Y X
A ₁	S ₁	S ₁	S ₁
A ₂	S ₂	S ₂	S ₂

1. There are two Factors (A and B) with p,q levels of treatments, respectively. Factor A is designated as the between block or nonrepeated measure. Factor B is the within block or repeated measure. The above example includes two levels of Factor A, three levels of Factor B.

2. Subjects from a common population are randomly assigned to the levels of Factor A. After this, levels of treatment B are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.
3. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.
4. The relationship of the dependent variable and the covariate is linear.
5. For repeated measures, the dependent measure for each subject is paired with a unique covariate measure. The covariate cannot be identical for all measures, e.g., age of the subject.

User Considerations and Procedures:

1. A data file must be created sequentially with two variables per record - the dependent variable (Y) first, then the covariate (X). On read input, vary the subject fastest, then B, and finally A. (For example, record one contains subject one for treatment and covariate of ab_{11} , record two is subject two, ab_{11} ; continue for all subjects in treatment ab_{11} . Next, enter all subjects for treatment ab_{12} ; repeat for ab_{1q} . Then enter data for $ab_{21} \dots$; the final record would be subject ab_{pq} .) A printout of raw data would show two data points per line.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of levels of Factor A (see comments)
 - b. number of levels of Factor B (see comments)

- c. number of subjects per level of Factor A (maximum 100)
 - d. name of data file
 - e. format of data file
5. Printout gives:
- a. raw data by group (optional)
 - b. for each group: N , Σy , Σy^2 , $\bar{Y}$, SD
 - c. ANOVA source table
 - d. intermediate calculations of the adjusted scores
 - e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependent variable. With analysis of covariance the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on the printout of the data must be used to adjust the means. Computational procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 482-485.

This program has the following restrictions:

- 1. The number of subjects for each level of A should be equal.
- 2. There cannot be more than 1,000 treatment combinations ($p*q \leq 1000$).

Test Data

This program was tested by comparing the results of the AC21B program to results obtained from a similar PDP 8/e Analysis of Covariance program. The program uses double precision in all calculations.

RU,AC21B
 AC21B OR
 SPFAC-P,Q ANALYSIS OF COVARIANCE TWO FACTORS MIXED
 DESIGN: REPEATED MEASURES ON FACTOR B. ON INPUT INDEX
 FOR SUBJECTS FIRST, THEN FOR WITHIN FACTOR B, THEN
 BETWEEN FACTOR A. ENTER TWO POINTS PER LINE - DEPENDENT
 VARIABLE AND THEN THE COVARIATE
 ENTER DATA FILE NAME
 #JSPFA
 ENTER DATA FORMAT
 (2(2X,F8.4))
 ENTER THE RECORD LENGTH AS IN DA30
 20
 ENTER 1 FOR CRT DISPLAY, 6 FOR PRINTER
 6
 ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0
 1
 HOW MANY LEVELS OF A?
 3
 HOW MANY LEVELS OF B?
 2
 SS/LEVEL OF A?
 3
 AC21B : STOP 0000
 :

Y	X
8.0000	3.0000
11.0000	5.0000
16.0000	11.0000

14.0000	4.0000
18.0000	9.0000
22.0000	14.0000

6.0000	2.0000
12.0000	8.0000
9.0000	10.0000

8.0000	1.0000
14.0000	9.0000
10.0000	9.0000

10.0000	7.0000
14.0000	8.0000
15.0000	9.0000

10.0000	4.0000
18.0000	10.0000
22.0000	12.0000

Y-TERMS (DEPENDENT VARIABLE)

(A)	3220.5000	(B)	3188.5556	(AB)	3305.0000
(ABS)	3495.0000	(Y)	3120.5000	(AS)	3397.5000

X-TERMS (COVARIABLE)

(A)	1022.8333	(B)	1017.0000	(AB)	1034.3333
(ABS)	1233.0000	(X)	1012.5000	(AS)	1207.5000

XY-TERMS

(A)	1807.5000	(B)	1795.0000	(AB)	1835.6667
(ABS)	2004.0000	(XY)	1777.5000	(AS)	1964.0000

CELL	N	SUMX	SUMX2	MEAN	SD
1 1	3	35.000	441.000	11.667	4.041
1 2	3	54.000	1004.000	18.000	4.000
2 1	3	27.000	261.000	9.000	3.000
2 2	3	32.000	360.000	10.667	3.055
3 1	3	39.000	521.000	13.000	2.646
3 2	3	50.000	908.000	16.667	6.110

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	54.259	2.000	27.129	3.057	.136
ERRCR	44.370	5.000	8.874		
B	31.547	1.000	31.547	52.613	.001
AB	2.339	2.000	1.170	1.951	.236
ERROR	2.998	5.000	.600		
TOTAL	141.837	15.			

CORRELATION COEFFICIENTS

A	.933
ERROR	.866
B	1.000
AB	.994
ERROR	.877
TOTAL	.788

"AC21B T=00004 IS ON CR00002 USING 00030 BLKS R=0238

```

0001  FTH4
0002      PROGRAM AC21B
0003      INTEGER P,Q,D
0004      DOUBLE PRECISION BXX(100),BYY(100),EXX(100),EYY(100)
0005      DIMENSION IB(272),IBUF(256),HFILE(3),IFMT(20)
0006      DOUBLE PRECISION SUMX(1000),SUMX2(1000)
0007      DOUBLE PRECISION X,Y,SX,SY,ZS,YS,XS,SA,AS,SN,SSN,BA,AB,ZZ,AX,
0008      CAY,
0009      IAZ,ASQN,SAQN,EX,EY,EZ,SZ,BY,BZ,BX,BXPH,BYPH,C,DD,ZI,SK,D,AYBZ,
0010      IBYSX,BASX,PQN,PH,XN,QZ,FH
0011      DO 1054 I=1,100
0012          BXX(I)=0.
0013          BYY(I)=0.
0014          EXX(I)=0.
0015      1054  EYY(I)=0.
0016      WRITE(1,3999)
0017      3999  FORMAT("AC21B OR ",/,
0018      C"SPFAC-P.Q ANALYSIS OF COVARIANCE TWO FACTORS MIXED",/
0019      @,12X,"DESIGN : REPEATED MEASURES ON FACTOR B. ON INPUT INDEX",
0020      $/,12X,"FOR SUBJECTS FIRST, THEN FOR WITHIN FACTOR B , THEN ",/,
0021      X12X,"BETWEEN FACTOR A. ENTER TWO POINTS PER LINE - DEPENDENT",
0022      Z/,12X,"VARIABLE AND THEN THE COVARIATE",/,
0023      C"ENTER DATA FILE NAME ")
0024      READ(1,87) HFILE
0025      87    FORMAT(3A2)
0026      WRITE(1,99)
0027      99    FORMAT("ENTER DATA FORMAT ")
0028      READ(1,123) IFMT
0029      123   FORMAT(20A2)
0030      IDCBS=256
0031      CALL OPEN(IB,IER,HFILE,3,0,-2,IDCBS)
0032      IF (IER.GE.0) GO TO 546
0033      WRITE(1,430) HFILE,IER
0034      430   FORMAT(3A2," FAILED TO OPEN, IER = ",I5)
0035      STOP 430
0036      546   WRITE(1,209)
0037      209   FORMAT("ENTER 1 FOR CRT DISPLAY, 6 FOR PRINTER")
0038      READ(1,*) IUNIT
0039      WRITE(1,219)
0040      219   FORMAT("ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0")
0041      READ(1,*) IPT0
0042      WRITE(1,4401)
0043      4401   FORMAT ( " HOW MANY LEVELS OF A? ")
0044      READ(1,*) P
0045      WRITE(1,4402)
0046      4402   FORMAT ( "HOW MANY LEVELS OF B? ")
0047      READ(1,*) Q
0048      WRITE(1,4403)

```



```

0049 4403 FORMAT ( ' SS/LEVEL OF A? ' )
0050 READ(1,*) N
0051 XN=N
0052 PQH=P*Q*N
0053 QN=Q*N
0054 DO 250 I=1,P
0055 DO 330 J=1,Q
0056 IF(IPTO.EQ.1) WRITE(IUNIT,923)
0057 923 FORMAT(/)
0058 DO 440 K=1,N
0059 CALL READF(IB,IER,IBUF)
0060 CALL CODE
0061 READ(IBUF,IFMT) Y,X
0062 IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
0063 SX=SX+X
0064 II=(I-1)*Q+J
0065 SUMX(II)=SUMX(II)+Y
0066 SUMX2(II)=SUMX2(II)+Y*Y
0067 SY=SY+Y
0068 ZS=ZS+X*Y
0069 YS=YS+Y*Y
0070 XS=XS+X*X
0071 SA=SA+X
0072 AS=AS+Y
0073 SN=SN+X
0074 SSH=SSH+Y
0075 BXX(J)=BXX(J)+X
0076 BYY(J)=BYY(J)+Y
0077 EXX(K)=EXX(K)+X
0078 440 EYY(K)=EYY(K)+Y
0079 BA=BA+SSH*SSH/XN
0080 AB=AB+SN*SN/XN
0081 ZZ=ZZ+SSH*SN/XN
0082 SNSN=SSH/XN
0083 SNH=SN/XN
0084 SM=0
0085 330 SSH=0
0086 AX=AX+SA*SA/QN
0087 AY=AY+AS*AS/QN
0088 AZ=AZ+SA*AS/QN
0089 ASQN=AS/QN
0090 SAQN=SA/QN
0091 QZ=Q
0092 PH=P*N
0093 DO 720 K=1,N
0094 EX=EX+EXX(K)*EXX(K)/QZ
0095 EY=EY+EYY(K)*EYY(K)/QZ
0096 EZ=EZ+EXX(K)*EYY(K)/QZ
0097 EXX(K)=0
0098 720 EYY(K)=0
0099 SA=0
0100 250 AS=0
0101 SZ=SY*SY/PQH
0102 SY=SY*SY/PQH
0103 SX=SX*SY/PQH
0104 DO 620 J=1,Q

```

```

0105      BY=BY+BYX(J)*BYX(J)/PN
0106      BX=BX+BXX(J)*BXX(J)/PN
0107      BZ=BZ+BXX(J)*BYX(J)/PN
0108      BYPH=BYX(J)/PN
0109      BXPB=BXX(J)/PN
0110 620    CONTINUE
0111      WRITE(IUNIT,170)
0112 170    FORMAT(/,1X," Y-TERMS (DEPENDENT VARIABLE)",/)
0113      WRITE(IUNIT,171)AY,BY,BA
0114 171    FORMAT(1X," (A)",F9.4,5X," (B)",F9.4,4X," (AB)",F9.4)
0115      WRITE(IUNIT,175)YS,SY,EY
0116 175    FORMAT(1X,"(ABS)",F9.4,5X," (Y)",F9.4,4X," (AS)",F9.4)
0117      WRITE(IUNIT,177)
0118 177    FORMAT(1X,/, " X-TERMS (COVARIABLE)",/)
0119      WRITE(IUNIT,180)AX,BX,AB
0120 180    FORMAT(1X," (A)",F9.4,5X," (B)",F9.4,5X," (AB)",F9.4)
0121      WRITE(IUNIT,181)XS,SX,EX
0122 181    FORMAT(1X,"(ABS)",F9.4,5X," (X)",F9.4,5X," (AS)",F9.4)
0123      WRITE(IUNIT,185)
0124 185    FORMAT(1X," XY-TERMS",/)
0125      WRITE(IUNIT,186)AZ,BZ,ZZ
0126 186    FORMAT(1X," (A)",F9.4,5X," (B)",F9.4,5X," (AB)",F9.4)
0127      WRITE(IUNIT,190)ZS,SZ,EZ
0128 190    FORMAT(1X,"(ABS)",F9.4,5X," (XY)",F9.4,5X," (AS)",F9.4)
0129      WRITE(IUNIT,1270)
0130 1270   FORMAT(////,"0 CELL",4X,"N",7X,"SUMX",6X,"SUMX2",9X,"MEAN",
0131         110X,"SD",/)
0132      DO 700 I=1,P
0133      DO 700 J=1,Q
0134      II=(I-1)*Q+J
0135      XB1=SUMX(II)/XN
0136      SD1=DSQRT((SUMX2(II)-(SUMX(II)*SUMX(II))/XN)/(XN-1.))
0137      WRITE(IUNIT,956) I,J,N,SUMX(II),SUMX2(II),XB1,SD1
0138 956    FORMAT(1X,2I3,2X,I3,4(3X,F10.3))
0139 700    CONTINUE
0140      SA=(AZ-SZ)/DSQRT((AY-SY)*(AX-SX))
0141      AS=(BZ-SZ)/DSQRT((BY-SY)*(BX-SX))
0142      X=(ZS-SZ)/DSQRT((YS-SY)*(XS-SX))
0143      SN=(ZZ+SZ-AZ-BZ)/DSQRT((BA+SY-AY-BY)*(AB+SX-AX-BX))
0144      SSH=(ZS+AZ-ZZ-EZ)/DSQRT((YS+AY-BA-EY)*(XS+AX-AB-EX))
0145      Y=(EZ-AZ)/DSQRT((EY-AY)*(EX-AX))
0146      C=SY
0147      DD=SX
0148      ZI=SZ
0149      SY=YS+AY-BA-EY
0150      SX=XS+AX-AB-EX
0151      SZ=ZS+AZ-ZZ-EZ
0152      EY=EY-AY
0153      EX=EX-AX
0154      EZ=EZ-AZ
0155      ZK=EY-EZ*EZ/EX
0156      BA=BA+C-AY-BY
0157      AB=AB+DD-AX-BX
0158      ZZ=ZZ+ZI-AZ-BZ

```

```

0159      AY=AY-C
0160      AX=AX-DD
0161      AZ=AZ-ZI
0162      BY=BY-C
0163      BX=BX-DD
0164      BZ=BZ-ZI
0165      YS=YS-C
0166      XS=XS-DD
0167      ZS=ZS-ZI
0168      C=SY-SZ*SZ/SX
0169      AX=(AY+EY)-(AZ+EZ)*(AZ+EZ)/(AX+EX)-ZK
0170      BX=(BY+SY)-(BZ+SZ)*(BZ+SZ)/(BX+GX)-C
0171      AZ=ZK
0172      K=P*(N-1)-1
0173      BZ=AZ/K
0174      AB=(BA+SY)-(ZZ+SZ)*(ZZ+SZ)/(AB+SX)-C
0175      XS=YS-ZS*ZS/XS
0176      J=K*P*Q-3
0177      D=P*(Q-1)*(N-1)-1
0178      P=P-1
0179      Q=Q-1
0180      I=P*Q
0181      AY=AX/P
0182      BY=BX/Q
0183      BA=AB/I
0184      SX=C/D
0185      WRITE(IUNIT,545)
0186 545    FORMAT(12X,///,"                      SOURCE TABLE",//)
0187      WRITE(IUNIT,550)
0188 550    FORMAT(" SOURCE",5X,"SS",13X,"DF",7X,"MS",18X,"F",11X,"P(F)")
0189      AYBZ=AY/BZ
0190      TP=P
0191      TK=K
0192      F=AYBZ
0193      CALL FPROB(F,TP,TK,Z1,PF1)
0194      WRITE(IUNIT,555)AX,P,AY,AYBZ,PF1
0195 555    FORMAT(1X,"A",3X,F7.3,5X,F7.3,5X,F7.3,8X,F7.3,8X,F7.3)
0196      WRITE(IUNIT,571)AZ,K,BZ
0197 571    FORMAT(1X,"ERROR",3X,F7.3,5X,F7.3,5X,F7.3)
0198      BYSX=BY/SX
0199      F=BYSX
0200      DF1=Q
0201      DF2=D
0202      CALL FPROB(F,DF1,DF2,Z2,PF2)
0203      WRITE(IUNIT,556)BX,Q,BY,BYSX,PF2
0204 556    FORMAT(1X,"B",3X,F7.3,5X,F7.3,5X,F7.3,8X,F7.3,8X,F7.3)
0205      BASX=BA/SX
0206      F=BASX
0207      DF1=I
0208      CALL FPROB(F,DF1,DF2,Z3,PF3)
0209      WRITE(IUNIT,560)AB,I,BA,BASX,PF3
0210 560    FORMAT(1X,"AB",3X,F7.3,5X,F7.3,5X,F7.3,8X,F7.3,8X,F7.3)
0211      WRITE(IUNIT,561)C,D,SX
0212 561    FORMAT(1X,"ERROR",3X,F7.3,5X,F7.3,5X,F7.3,/)
0213      WRITE(IUNIT,565)XS,J

```

```

0214 565  FORMAT(1X,"TOTAL ",3X,F7.3,8X,I3,/)
0215      WRITE(IUNIT,810)SA,Y
0216 810  FORMAT(1X,"CORRELATION COEFFICIENTS",/, " A      ",4X,F5.3,/, " ERR
0217      XOR",4X,F5.3)
0218      WRITE(IUNIT,820)AS,SN,SSN
0219 820  FORMAT(1X,"B      ",4X,F5.3,/, " AB      ",4X,F5.3,/, " ERROR",4X,
0220      CF5.3,/)
0221      WRITE(IUNIT,999)X
0222 999  FORMAT(" TOTAL",4X,F5.3)
0223      CALL CLOSE(IB)
0224      STOP
0225      END
0226      END$

```

C. Multivariate Analysis of Variance

MAV10 (Multivariate One-way ANOVA)

Purpose:

This program performs a multivariate one-way analysis of variance.

Mathematical Model:

The model for this design is:

$$X_{ij}(r) = u_{(k)} + B_{j(r)} + E_{ij}(r)$$

The hypothesis to be tested is:

$$H_0: B_{jr} = 0 \text{ for all } jr$$

Layout of Design:

1. Same as AV10 except each treatment has multiple dependent variables.
2. Each subject has r responses.
3. There are k levels of treatments.
4. Subjects are randomly assigned to the treatment levels with each subject designated to receive only one level.
5. Under each treatment, there are an equal number of (NR) observations.

User Considerations and Procedures:

1. A matrix data file must be created with r data points per line. On input, index observations under each treatment fastest, then treatment. (For example, the first record contains r responses for subject one, treatment b_1 ; second record contains r responses for subject two, treatment b_1 . . . then r responses for subject one, treatment b_2 . . . , last record contains responses for subject n treatment b_k). A printout of raw data would show r data points per line.
2. The data analysis can either be displayed on the CRT or a hard copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. A printout of the sums of squares and cross products matrix (error matrix) can be obtained. Option: 1 if printout desired, 0 for no printout.
5. Parameters required:
 - a. number of treatments (maximum 20)
 - b. number of responses per subject (maximum 30)
 - c. number of subjects per treatment level (maximum 30)
 - d. name of data file
 - e. format of data file
6. Printout gives:
 - a. raw data (optional)
 - b. error matrix (optional)
 - c. the U-statistic with degrees of freedom
 - d. approximate F-value, degrees of freedom, and approximate alpha level

Test Data:

This program was tested using data from Clyde Kramer's, A First Course in Multivariate Analysis, Clyde Kramer, Publisher, 1972, Pp. 121-144.

RU, MAVIO

SU,4

ONE-WAY MANOVA WITH NO RANDOMIZED BLOCKS

ENTER NAME OF YOUR DATA FILE

OMAVIO

ENTER DATA FORMAT

(F4.1,1X,F3.1)

ENTER NUMBER OF TREATMENTS AND NUMBER OF VARIABLES

4,2

ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0

1

ENTER 1 FOR CRT, 6 FOR LINEPRINTER

1

ENTER NUMBER OF OBSERVATIONS FOR TREATMENT 1

7

24.03.5

13.33.5

12.24.0

14.04.0

22.23.6

16.14.3

27.95.2

ENTER NUMBER OF OBSERVATIONS FOR TREATMENT 2

7

7.43.5

13.23.0

8.53.0

10.13.0

9.32.0

8.32.5

4.31.5

ENTER NUMBER OF OBSERVATIONS FOR TREATMENT 3

5

16.43.2

24.02.5

53.01.5

32.72.6

42.82.0

ENTER NUMBER OF OBSERVATIONS FOR TREATMENT 4

2

25.12.7

5.92.3

ENTER 1 FOR PRINTOUT OF ERROR MATRIX

1

THE ERROR SS AND CP MATRIX

ROW 1
 .13026794285D+04 -.17644000001D+02
 ROW 2
 -.1764400000D+02 .67777142865D+01
 THE U-STATISTIC EQUALS .15961411397D+00
 WITH DEGREES OF FREEDOM 2 3 20
 THE APPROXIMATE F-VALUE, DEGREES OF FREEDOM
 3.51913 6 38
 AND THE ALPHA LEVEL IS .0000195
 MAV02 ABORTED
 :

MAV10 T=00003 IS ON CR00002 USING 00001 BLKS R=0000

0001 :SV,4
0002 :RP,MAV02
0003 :RU,MAV01
0004 :OF,MAV02
0005 :SV,0

*MAY01 T=00003 IS ON CR00002 USING 00013 BLKS R=0000

```

0001 FTH4.L
0002 PROGRAM MAY01
0003 DOUBLE PRECISION Y(30),T(20,30),G(30),H(30,30),E(30,30),
0004 ISUM,TH,SU,DET,DETH,T4,DF1,DF2
0005 INTEGER R
0006 COMMON I,J,R,H,E,DET,DETH,IUNIT,TH,T,G,Y,H(30),NAME(3),IFMT(20)
0007 COMMON IB(272),IBUF(256)
0008 DIMENSION NM(3)
0009 DATA NM/2HMA,2HVO,1H2/
0010 WRITE(1,1)
0011 1 FORMAT(5X,"ONE-WAY MANOVA WITH NO RANDOMIZED BLOCKS",/)
0012 WRITE(1,2)
0013 2 FORMAT("ENTER NAME OF YOUR DATA FILE")
0014 READ(1,3) NAME
0015 3 FORMAT(3A2)
0016 WRITE(1,4)
0017 4 FORMAT("ENTER DATA FORMAT")
0018 READ(1,5) IFMT
0019 5 FORMAT(20A2)
0020 CALL OPEN(IB,IER,NAME,3,0,0,256)
0021 IF(IER.GE.0) GO TO 10
0022 WRITE(1,6) NAME,IER
0023 6 FORMAT(3A2," FAILED TO OPEN, IER = ",I5)
0024 STOP
0025 10 WRITE(1,11)
0026 11 FORMAT("ENTER NUMBER OF TREATMENTS AND NUMBER OF VARIABLES")
0027 READ(1,*) J,R
0028 C INITIALIZE ALL SS AND SCP AND SUMS
0029 NT=0
0030 DO 20 I=1,J
0031 DO 20 K=1,R
0032 20 T(I,K)=0.000
0033 DO 30 I=1,R
0034 G(I)=0.00
0035 DO 30 K=1,R
0036 E(I,K)=0.00
0037 30 H(I,K)=0.000
0038 WRITE(1,40)
0039 40 FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0")
0040 READ(1,*) IPT0
0041 WRITE(1,41)
0042 41 FORMAT("ENTER 1 FOR CRT, 6 FOR LINEPRINTER")
0043 READ(1,*) IUNIT
0044 DO 50 I=1,J
0045 WRITE(1,51) I
0046 51 FORMAT("ENTER NUMBER OF OBSERVATIONS FOR TREATMENT",I5)
0047 READ(1,*) H(I)
0048 TH=TH+H(I)
0049 IF((IPT0.EQ.1).AND.(IUNIT.EQ.6)) WRITE(6,52) I
0050 52 FORMAT(//,10X,"TREATMENT ",I5,/)
0051 DO 50 IV=1,H(I)

```

```

0052      CALL READF(IB,IER,IBUF)
0053      CALL CODE
0054      READ(IBUF,IFMT) (Y(K),K=1,R)
0055      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT)(Y(K),K=1,R)
0056      DO 53 K=1,R
0057          T(I,K)=T(I,K)+Y(K)
0058          G(K)=G(K)+Y(K)
0059      53  CONTINUE
0060      50  CONTINUE
0061      CALL RWNDF(IB)
0062      C    CALCULATE H MATRIX
0063      DO 200 I=1,R
0064          DO 200 L=1,R
0065              SUM=0.D0
0066              DO 210 K=1,J
0067      210  SUM=SUM+T(K,L)*T(K,I)/H(K)
0068          E(I,L)=-SUM
0069      200  H(I,L)=SUM-G(I)*G(L)/TH
0070      C    CAL. E MATRIX
0071      DO 300 I=1,R
0072          DO 300 L=1,R
0073              SU=0.D0
0074              DO 320 M=1,J
0075                  DO 320 M1=1,H(M)
0076                      CALL READF(IB,IR,IBUF)
0077                      CALL CODE
0078                      READ(IBUF,IFMT)(Y(IK),IK=1,R)
0079                      SU=SU+Y(I)*Y(L)
0080      320  CONTINUE
0081      CALL RWNDF(IB)
0082      300  E(I,L)=E(I,L)+SU
0083      WRITE(1,157)
0084      157  FORMAT("ENTER 1 FOR PRINTOUT OF ERROR MATRIX")
0085      READ(1,*) IPTO
0086      IF(IPTO.NE.1) GO TO 507
0087      C    WRITE OUT E MATRIX
0088      WRITE(IUNIT,500)
0089      500  FORMAT(/10X,"THE ERROR SS AND CP MATRIX",/)
0090      DO 501 I=1,R
0091          WRITE(IUNIT,503) I
0092      503  FORMAT(/,5X,"ROW",I5)
0093      501  WRITE(IUNIT,502) (E(I,K),K=1,R)
0094      502  FORMAT(5(5X,D17.11))
0095      C    CREAT H+E MATORIX      .... H
0096      507  DO 600 I=1,R
0097          DO 600 K=1,R
0098      600  H(I,K)=H(I,K)+E(I,K)
0099      CALL CLOSE(IB)
0100      CALL EXEC(9,NM)
0101      END
0102      END$

```

"NAV02 T=00003 IS ON CR00002 USING 00006 BLKS R=0000

```

0001 FTH4,L
0002     PROGRAM NAV02
0003     INTEGER R
0004     DOUBLE PRECISION H(30,30),E(30,30),DET,DETH,SU,SUM,T4,DF1,DF2
0005     DOUBLE PRECISION TH
0006     COMMON I,J,R,H,E,DET,DETH,IUNIT,TH
0007     CALL MINV(H,R,DETH)
0008     CALL MINV(E,R,DET)
0009     DET=DET/DETH
0010     I1=J-1
0011     I2=TH-1
0012     I3=TH-2
0013     WRITE(IUNIT,800) DET
0014 800   FORMAT(//,5X,"THE U-STATISTIC EQUALS",5X,D16.11)
0015     WRITE(IUNIT,802) R,I1,I2
0016 802   FORMAT(//,5X,"WITH DEGREES OF FREEDOM      ",3(I7))
0017 C    FIND APPROX. F LEVEL
0018     IF(R.NE.2) GO TO 900
0019     DETH=(1-DSQRT(DET))/DSQRT(DET)
0020     D=DETH*I3/I1
0021     E1=2*I1
0022     DE=2*(I2-1)
0023     GO TO 901
0024 900   SUM=R*R+(J-1)*(J-1)
0025     SU=1
0026     IF(SUM.LE.5.000) GO TO 801
0027     SU=DSQRT((R*R*(J-1)*(J-1)-4.)/(SUM-5.))
0028 801   T4=TH-1-(J+R)/2.
0029     DETH=DET**(.1/SU)
0030     DF1=R*(J-1)
0031     DF2=1+T4*SU-R*(J-1)/2.
0032     DETH=((1.-DETH)/DETH)*DF1/DF2
0033 C    USE SINGLE PRECISION IN CALL TO FPROB
0034     D=DETH
0035     E1=DF1
0036     DE=DF2
0037 901   CALL FPROB(D,E1,DE,SD,FPR)
0038     WRITE(IUNIT,902) D,E1,DE,FPR
0039 902   FORMAT(//," THE APPROXIMATE F-VALUE, DEGREES OF FREEDOM "
0040 & //," = ",5X,F10.5,2(I7),//," AND THE ALPHA LEVEL IS",
0041 & 5X,F10.7)
0042     END
0043     END$

```

MAV11 (Multivariate Two-way ANOVA, Repeated Measures)

Purpose:

This program performs a multivariate one-way analysis of variance with replication either using matched subjects or by repeated measures.

Mathematical Model:

The model for this analysis is:

$$X_{ij(r)} = \mu(r) + \pi_i(r) + B_j(r) + E_{ij(r)}$$

The hypothesis to be tested is:

$$H_0: B_{jr} = 0 \text{ for all } jr$$

Layout of Design:

1. Same as AV11 except each treatment has multiple dependent variables
2. Each subject has r responses
3. There are k levels of treatment B
4. Subjects are assigned to a treatment so that variability within a treatment is less than the variability among treatments. Homogeneity within treatments may be achieved by using a subject as his own control or by using subjects matched on the basis of a variable that correlates with the dependent variable
5. Under each treatment there are equal number (NR) observations

User Considerations and Procedures:

1. A matrix data file must be created with r responses per record. On input, index responses fastest, then subjects, and treatment slowest. (For example, first record contains r responses for subject one, treatment b_1 ; second record contains r responses for subject two, treatment b_1 . . ., then r responses for subject one, treatment b_2 . . ., the last record contains the r responses for subject N , treatment b_k .) A printout would show r data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. A printout of the sums of squares and cross product matrix (error matrix) can be obtained. Option: 1 if printout is desired, 0 for no printout.
5. Parameters required:
 - a. number of subjects (maximum 20)
 - b. number of treatments (maximum 20)
 - c. number of responses per subject (maximum 30)
 - d. name of data file
 - e. format of data file
6. Printout gives:
 - a. raw data (optional)
 - b. error matrix (optional)
 - c. block (subject) totals for each dependent variable
 - d. treatment totals for each dependent variable
 - e. the U-statistics with degrees of freedom
 - f. approximate F-test with degrees of freedom and alpha level

Comments:

Mount a scratch tape before running program.

Test Data:

This program was tested from Clyde Kramer's, A First Course in Multivariate Analysis, Clyde Kramer, Publisher, 1972, Pp 145-158.

RU, MAV11

SU,4

PROGRAM TO PERFORM ONE-WAY MANOVA WITH
REPEATED MEASURES (OR RANDOMIZED BLOCKS)

ENTER NAME OF DATA FILE

#MAV11

ENTER FORMAT OF FILE

(3(2X,F3.0))

ENTER NUMBER OF BLOCKS, TREATMENTS, AND VARIATES

4,5,3

ENTER 1 FOR LISTING OF RAW DATA, ELSE ENTER 0

1

ENTER 1 FOR ERROR MATRIX PRINTOUT, ELSE ENTER 0

1

ENTER 1 FOR CRT, OR 6 FOR LINE PRINTER OUTPUT

6

ENTER 1 FOR PRINTOUT OF TREATMENT AND BLOCK TOTALS

1

MAV1B ABORTED

MAV1C ABORTED

RAW DATA

TREATMENT			1
96.	10.	725	
142.	16.	700	
122.	13.	655	
111.	13.	680	

TREATMENT			2
102.	15.	695	
106.	10.	710	
95.	14.	705	
93.	12.	680	

TREATMENT			3
109.	15.	690	
113.	15.	690	
101.	14.	680	
100.	19.	685	

TREATMENT			4
103.	17.	680	
97.	16.	690	
99.	13.	730	
135.	12.	670	

TREATMENT			5
98.	17.	680	
97.	14.	695	
105.	16.	680	
86.	22.	710	

PRINTOUT OF BLOCK TOTALS

508.00000	74.00000	3470.00000
555.00000	71.00000	3485.00000
522.00000	70.00000	3450.00000
525.00000	78.00000	3425.00000

PRINTOUT OF TREATMENT TOTALS

471.00000	52.00000	2760.00000
396.00000	51.00000	2790.00000
423.00000	63.00000	2745.00000
434.00000	58.00000	2770.00000
386.00000	69.00000	2765.00000

THE ERROR SS AND CP MATRIX IS

.22589000001D+04	-.2464999998D+02	-.1658250000D+04
-.2464999998D+02	.91500000000D+02	.40000000000D+01
-.1658250000D+04	.40000000000D+01	.55325000000D+04

THE U-STATISTIC EQUALS .3990056930
 WITH DEGREES OF FREEDOM 3 4 12

THE APPROXIMATE F VALUE, DEGREES OF FREEDOM,
 = 1.20013 12 35
 AND THE ALPHA LEVEL IS .3212206

MAV11 T-00004 IS ON CR00002 USING 00001 BLKS R=0009

0001 :SV,4
0002 :CN
0003 :RP,MAV1B
0004 :RP,MAV1C
0005 :RU,MAV1A
0006 :OF,MAV1B
0007 :OF,MAV1C
0008 :CN
0009 :SV,0
0010 :

"MAV1A T=00003 IS ON CR00002 USING 00008 BLKS R=0000

```

0001 FTH4,L
0002 PROGRAM MAV1A
0003 DOUBLE PRECISION Z(30)
0004 INTEGER B,T,P
0005 COMMON B,T,P,IUNIT,IPT,IPT1,IFMT(20),IBUF(256),IB(272),Z
0006 DIMENSION NM(3),NAME(3)
0007 DATA NM/2HMA,2HV1,1H8/
0008 REWIND 8
0009 WRITE(1,1)
0010 1 FORMAT("PROGRAM TO PERFORM ONE-WAY MANOVA WITH ",//,
0011 &"REPEATED MEASURES ( OR RANDOMIZED BLOCKS)",//)
0012 WRITE(1,2)
0013 2 FORMAT("ENTER NAME OF DATA FILE")
0014 READ(1,3) NAME
0015 3 FORMAT(3A2)
0016 WRITE(1,4)
0017 4 FORMAT("ENTER FORMAT OF FILE")
0018 READ(1,5) IFMT
0019 5 FORMAT(20A2)
0020 WRITE(1,6)
0021 6 FORMAT("ENTER NUMBER OF BLOCKS,TREATMENTS, AND VARIATES")
0022 READ(1,*) B,T,P
0023 CALL OPEN(IB,IER,NAME,3,0,0,272)
0024 IF(IER.GE.0) GO TO 20
0025 WRITE(1,7) NAME,IER
0026 7 FORMAT(3A2,5X,"FAILED TO OPEN, IER = ",I5)
0027 STOP 7777
0028 20 WRITE(1,21)
0029 21 FORMAT("ENTER 1 FOR LISTING OF RAW DATA, ELSE ENTER 0")
0030 READ(1,*) IPT0
0031 WRITE(1,22)
0032 22 FORMAT("ENTER 1 FOR ERROR MATRIX PRINTOUT, ELSE ENTER 0")
0033 READ(1,*) IPT
0034 WRITE(1,23)
0035 23 FORMAT("ENTER 1 FOR CRT, OR 6 FOR LINEPRINTER OUTPUT")
0036 READ(1,*) IUNIT
0037 IF(IPT0.EQ.1) WRITE(IUNIT,24)
0038 24 FORMAT(//,5X,"RAW DATA",//)
0039 DO 30 I=1,T
0040 IF(IPT0.EQ.1) WRITE(IUNIT,25) I
0041 25 FORMAT(/,10X,"TREATMENT ",I7)
0042 DO 30 J=1,B
0043 CALL READF(IB,IER,IBUF)
0044 CALL CODE
0045 READ(IBUF,IFMT) (Z(K),K=1,P)
0046 IF(IPT0.EQ.1) WRITE(IUNIT,IFMT) (Z(K),K=1,P)
0047 30 WRITE(8,IFMT) (Z(K),K=1,P)
0048 ENDFILE 8
0049 REWIND 8
0050 CALL CLOSE(IB)
0051 WRITE(1,60)
0052 60 FORMAT(//,"ENTER 1 FOR PRINTOUT OF TREATMENT AND BLOCK TOTALS")
0053 READ(1,*) IPT1
0054 CALL EXEC(9,NM)
0055 END
0056 END$

```

*NAV1B T=00003 IS ON CR00002 USING 00009 BLKS R=0000

```

0001  FTH4,L
0002      PROGRAM NAV1B
0003      DOUBLE PRECISION B1(20,30),T1(20,30),G(30),H(30,30),E(30,30),
0004      &Y(30),BL,BK,TI,SUM
0005      INTEGER B,T,P
0006      COMMON B,T,P,IUNIT,IPT,ITP1,IFMT(20),H,E,B1,H1,G,Y
0007      DIMENSION NM(3)
0008      DATA NM/2HMA,2HV1,1HC/
0009      DO 10 I=1,20
0010      DO 10 J=1,30
0011      G(J)=0.00
0012      B1(I,J)=0.00
0013  10    T1(I,J)=0.00
0014      CALL ENDIO
0015      DO 30 I=1,T
0016      DO 30 J=1,B
0017      READ(8,IFMT) (Y(II),II=1,P)
0018      DO 30 K=1,P
0019      B1(J,K)=B1(J,K)+Y(K)
0020  30    T1(I,K)=T1(I,K)+Y(K)
0021      REWIND 8
0022      DO 40 K=1,P
0023      DO 40 I=1,B
0024  40    G(K)=G(K)+B1(I,K)
0025      BI=B
0026      BK=B*T
0027      TI=T
0028      IF(ITP1.NE.1) GO TO 41
0029      WRITE(IUNIT,42)
0030  42    FORMAT(//,5X,"PRINTOUT OF BLOCK TOTALS",/)
0031      DO 44 I=1,B
0032      WRITE(IUNIT,43)
0033  43    FORMAT(5X)
0034  44    WRITE(IUNIT,45) (B1(I,K),K=1,P)
0035  45    FORMAT(5(3X,F13.5))
0036      WRITE(IUNIT,46)
0037  46    FORMAT(///,5X,"PRINTOUT OF TREATMENT TOTALS",/)
0038      DO 47 I=1,T
0039      WRITE(IUNIT,43)
0040  47    WRITE(IUNIT,45) (T1(I,K),K=1,P)
0041  41    CONTINUE
0042      DO 50 I=1,P
0043      DO 50 J=1,P
0044      SUM=0.00
0045      DO 60 K=1,T
0046  60    SUM=SUM+T1(K,I)*T1(K,J)
0047      H(I,J)=SUM/BI-G(I)*G(J)/BK
0048      E(I,J)=-H(I,J)
0049      SUM=0.00
0050      DO 70 K=1,B

```

```

0051 70 SUM=SUM+B1(K,I)*B1(K,J)
0052 E(I,J)=E(I,J)-SUM/TI
0053 SUM=0.D0
0054 DO 90 I1=1,T
0055 DO 90 J1=1,B
0056 CALL ENDIO
0057 READ(8,IFMT) (Y(K),K=1,P)
0058 90 SUM=SUM+Y(I)*Y(J)
0059 E(I,J)=E(I,J)+SUM
0060 REWIND 8
0061 50 CONTINUE
0062 C H,E MATRIX COMPLETE OPTION FOR PRINT OF E
0063 IF(IPT.EQ.0) GO TO 100
0064 WRITE(IUNIT,500)
0065 500 FORMAT(//,10X,"THE ERROR SS AND CP MATRIX IS ",//)
0066 DO501 I=1,P
0067 WRITE(IUNIT,43)
0068 501 WRITE(IUNIT,502) (E(I,J),J=1,P)
0069 502 FORMAT(4(4X,D16.11))
0070 C CREAT H+E STORE IN H
0071 100 DO600 I=1,P
0072 DO600 J=1,P
0073 600 H(I,J)=H(I,J)+E(I,J)
0074 C FINISHED WITH THIS PART
0075 CALL EXEC(9,NH)
0076 END
0077 END$

```

*MAYIC T=00003 IS ON CR00002 USING 00007 BLKS R=0000

```

0001 FTH4,L
0002 PROGRAM MAYIC
0003 DOUBLE PRECISION H(30,30),E(30,30),DET,DET1,U,F
0004 DOUBLE PRECISION SUM,SU,T4,DF1
0005 INTEGER B,T,P
0006 COMMON B,T,P,IUNIT,ITP,ITP1,IFMT(20),H,E
0007 CALL MINV(E,P,DET)
0008 CALL MINV(H,P,DET1)
0009 U=DET/DET1
0010 C THE U-STATISTIC WITH DF P,I1,I2
0011 I1=T-1
0012 I2=(B-1)*I1
0013 I3=B*T
0014 C I1=DEGREES OF FREEDOM FOR HYPOTH I2=DF FOR ERROR
0015 C I3=TOTAL SAMPLE SIZE
0016 WRITE(IUNIT,100) U,P,I1,I2
0017 100 FORMAT(//,5X,"THE U-STATISTIC EQUALS",5X,F15.10,/,
0018 $5X,"WITH DEGREES OF FREEDOM ",3(5X,I7))
0019 C NEXT TO CAL APPROX F-VALUE
0020 C CHECK FOR EXACT F-VALUE
0021 IF(P.NE.2) GO TO 200
0022 DET=DSQRT(U)
0023 DET=(1-DET)/DET
0024 D=DET*(I2-1)/I1
0025 C D=EXACT F VALUE
0026 E1=I1*2
0027 DE=2*(I2-1)
0028 C CALL FPROB
0029 GO TO 300
0030 200 SUM=P*P+I1*I1
0031 SU=1.D0
0032 IF(SUM.LE.5.D0) GO TO 210
0033 SU=DSQRT((P*P+I1*I1-4.D0)/(SUM-5.D0))
0034 210 T4=I3-1-(I+P)/2.D0
0035 DET1=U**((1.D0/SU))
0036 DF1=P*I1
0037 DET=1+T4*SU-DF1/2.D0
0038 U=((1.D0-DET1)/DET1)*((DET/DF1))
0039 C USE SINGLE PRECISION ON FPROB CAL
0040 D=U
0041 E1=DF1
0042 DE=DET
0043 C D,E1,DE === F-VALUE,DEGREES OF FREEDOM
0044 C FPR= ALPHA - LEVEL
0045 300 CALL FPROB(D,E1,DE,SD,FPR)
0046 WRITE(IUNIT,902) D,E1,DE,FPR
0047 902 FORMAT(//," THE APPROXIMATE F-VALUE, DEGREES OF FREEDOM,"
0048 $,/,," = ",5X,F10.5,2(I7),/,," AND THE ALPHA LEVEL IS",
0049 $5X,F10.7)
0050 END
0051 END$

```

MAV20 (Multivariate Two-way ANOVA)

Purpose:

This program performs a two-way multivariate completely randomized analysis of variance.

Mathematical Model:

The model for this analysis is:

$$X_{ijk}(r) = M(r) + A_i(r) + B_j(r) + AB_{ij}(r) + E_{ijk}(r)$$

The hypotheses to be tested are:

$$H_0: A_{ir} = 0 \text{ for all } ir$$

$$H_0: B_{jr} = 0 \text{ for all } jr$$

$$H_0: AB_{ijr} = 0 \text{ for all } ijr$$

Layout of Design:

1. Same design as AV20, except each Factor has multiple dependent variables
2. Each subject has r responses
3. There are two factors (A,B) with p and q levels of treatments
4. Subjects are randomly assigned to the pq treatment combinations, with each subject receiving only one combination
5. There are an equal number of observations for each AB cell

User Considerations and Procedures:

1. A matrix data file must be created with r responses per record. On input subjects vary fastest, then factor B, and finally A. (For example, first record contains r responses for subject one, treatment ab_{11} , second record contains r responses for subject two, treatment ab_{11} . . . , then r responses for subject one, treatment ab_{12} . . . , then r responses for subject one, treatment ab_{21} . . . , final record would be r responses for subject k for treatment ab_{pq} .) A printout of raw data would show r data points per line.

2. The data analysis can be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. The printout of the sums of squares and cross product matrix (error matrix) can be obtained. Option: 1 if desired, 0 for no printout.
5. Parameters required:
 - a. number of levels of Factor A (maximum 20)
 - b. number of levels of Factor B (maximum 20)
 - c. number of subjects per AB cell (maximum 32767)
 - d. number of responses (r)
 - e. name of data file
 - f. format of data file
6. Printout gives:
 - a. raw data (optional)
 - b. error matrix (optional)
 - c. cell totals
 - d. the U-statistics with degrees of freedom

Test Data:

Program was tested from Clyde Kramer's, A First Course in Multivariate Analysis, Clyde Kramer, Publisher, 1972, Pp. 164-167.

RU, MAV20
TWO WAY MULTIVARIATE ANALYSIS OF VARIANCE

ENTER NAME OF RAW DATA FILE

#MAV20

ENTER FORMAT OF DATA

(3X,F4.1,2X,F5.1,2X,F4.1)

ENTER NUMBER OF LEVELS OF FACTOR A, FACTOR B, NUMBER OF VARIATES, AND
NUMBER OF OBSERVATIONS PER A,B TREATMENT CELL

2,3,3,4

ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER

6

ENTER 1 FOR RAW DATA LISTING, ELSE ENTER 0

1

ENTER 1 FOR PRINTOUT OF ERROR MATRIX, ELSE ENTER 0

1

ENTER 1 FOR PRINTOUT OF FACTOR TOTALS

1

RAW DATA

TREATMENT PAIR			1	1
40.1	85.6	46.8		
41.1	83.2	41.7		
40.9	79.5	38.1		
39.4	78.0	39.6		
CELL TOTALS				
.16150000000D+03			.32630000000D+03	.16620000000D+03

TREATMENT PAIR			1	2
63.0	102.4	44.8		
61.9	100.3	39.4		
61.6	101.3	39.9		
64.0	106.2	50.0		
CELL TOTALS				
.25050000000D+03			.41020000000D+03	.17410000000D+03

TREATMENT PAIR			2	1
52.8	114.4	47.1		
53.6	115.6	42.1		
53.9	114.2	42.3		
53.8	113.2	35.7		
CELL TOTALS				
.21410000000D+03			.45740000000D+03	.16720000000D+03

TREATMENT PAIR			2	2
68.6	129.8	42.7		
70.7	131.0	47.1		
69.1	135.8	45.2		
73.3	147.6	49.2		
CELL TOTALS				
.28170000000D+03			.54420000000D+03	.18420000000D+03

TREATMENT PAIR			3	1
41.6	142.3	45.8		
37.7	137.0	37.0		
43.2	143.8	44.0		
42.0	143.6	40.8		
CELL TOTALS				
.16450000000D+03			.56670000000D+03	.16760000000D+03

TREATMENT PAIR			3	2
62.8	164.4	44.4		
56.6	156.0	45.3		
63.3	161.3	46.3		
60.9	161.4	42.2		
CELL TOTALS				
.24360000000D+03			.64310000000D+03	.17820000000D+03

ERROR MATRIX

ROW #	1		
	.64497499943D+02	.10466500044D+03	.48837500215D+02
ROW #	2		
	.10466500044D+03	.32391249943D+03	.15558500028D+03
ROW #	3		
	.48837500215D+02	.15558500028D+03	.25961750042D+03

ROW TREATMENT TOTALS

ROW #	1		
	.41200000000D+03	.73650000000D+03	.34030000000D+03
ROW #	2		
	.49580000000D+03	.10016000000D+04	.35140000000D+03
ROW #	3		
	.40810000000D+03	.12098000000D+04	.34580000000D+03

COLUMN TREATMENT TOTALS

COLUMN	1		
	.54010000000D+03	.13504000000D+04	.50100000000D+03
COLUMN	2		
	.77580000000D+03	.15975000000D+04	.53650000000D+03

HYPOTHESIS TEST RESULTS

HYPOTHESIS OF	U-STATISTIC	DEGREES OF FREEDOM		
INTERACTION EFFECT	.47183408163D+00	3	2	18
FACTOR A EFFECT	.77473471183D-03	3	1	18
FACTOR B EFFECT	.23177578747D-01	3	2	18

"HAY20 T=00004 IS ON CR00002 USING 00029 BLKS R=0238

```

0001 FTH4,L
0002     PROGRAM HAY20
0003     INTEGER C,R,P
0004     DOUBLE PRECISION RIJ(30,30),G(30),X(30),SUM(30),RN,RCH,CH,SU
0005     DOUBLE PRECISION E(30,30),DETE,DET1,DET2,DET3
0006     COMMON C,R,P,N,IPT,IUNIT,RIJ,IFMT(20),IB(272),IBUF(256),
0007     $NAME(3),X,SUM,E
0008     EQUIVALENCE (G,SUM)
0009     REWIND 8
0010     WRITE(1,1)
0011 1     FORMAT("TWO WAY MULTIVARIATE ANALYSIS OF VARIANCE",/
0012     $/,"ENTER NAME OF RAW DATA FILE")
0013     READ(1,2) NAME
0014 2     FORMAT(3A2)
0015     CALL OPEN(1B,IER,NAME,3,0,0,272)
0016     IF(IER.GE.0) GO TO 20
0017 323   WRITE(1,3) NAME,IER
0018 3     FORMAT(3A2," FAILED TO OPEN, IER = ",I5)
0019     STOP
0020 20    WRITE(1,5)
0021 5     FORMAT("ENTER FORMAT OF DATA")
0022     READ(1,6) IFMT
0023 6     FORMAT(20A2)
0024     WRITE(1,7)
0025 7     FORMAT("ENTER NUMBER OF LEVELS OF FACTOR A, FACTOR B,",
0026     $"NUMBER OF VARIATES, AND ",/,"NUMBER OF OBSERVATIONS PER ",
0027     $"A,B TREATMENT CELL ")
0028     READ(1,*) C,R,P,N
0029     WRITE(1,14)
0030 14    FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER")
0031     READ(1,*) IUNIT
0032     WRITE(1,15)
0033 15    FORMAT("ENTER 1 FOR RAW DATA LISTING, ELSE ENTER 0")
0034     READ(1,*) IPT0
0035     WRITE(1,16)
0036 16    FORMAT("ENTER 1 FOR PRINTOUT OF ERROR MATRIX, ELSE ENTER 0")
0037     READ(1,*) IPT
0038     WRITE(1,17)
0039 17    FORMAT("ENTER 1 FOR PRINTOUT OF FACTOR TOTALS")
0040     READ(1,*) IPT1
0041     IF(IPT0.EQ.1) WRITE(IUNIT,13)
0042 13    FORMAT(/,5X,"RAW DATA",/)
0043     CALL ENDIO
0044     DO 30 I=1,R
0045     DO 30 J=1,C
0046     DO 40 K=1,N
0047 40    SUM(K)=0.00
0048     IF(IPT0.EQ.1) WRITE(IUNIT,11) I,J
0049 11    FORMAT(15X,"TREATMENT PAIR ",2I7)
0050     DO 50 K=1,N

```

```

0051      CALL READF(IB,IER,IBUF)
0052      CALL CODE
0053      READ(IBUF,IFMT) (X(I1),I1=1,P)
0054      IF(IPT0.EQ.1) WRITE(IUNIT,IFMT) (X(I1),I1=1,P)
0055      DO 30 I1=1,P
0056  50      SUM(I1)=SUM(I1)+X(I1)
0057      WRITE(8,51) (SUM(I1),I1=1,P)
0058  51      FORMAT(30D16.11)
0059      IF(IPT1.NE.1) GO TO 30
0060      WRITE(IUNIT,123)
0061  123      FORMAT(" CELL TOTALS")
0062      WRITE(IUNIT,522) (SUM(I1),I1=1,P)
0063      WRITE(IUNIT,533)
0064  522      FORMAT(5X,4(3X,D16.11))
0065  533      FORMAT(5X)
0066      30      CONTINUE
0067      CALL RWNDF(IB)
0068  C      NOW CREAT 888XIJKU*XIJKV INTO RIJ MTX
0069      REWIND 8
0070      CALL INIT(RIJ)
0071      DO 300 I=1,P
0072      DO 300 J=1,P
0073      SU=0.D0
0074      DO 400 L3=1,R
0075      DO 400 L1=1,C
0076      DO 400 L2=1,N
0077      CALL READF(IB,IER,IBUF)
0078      CALL CODE
0079      READ(IBUF,IFMT) (X(I1),I1=1,P)
0080  400      SU=SU+X(I)*X(J)
0081      RIJ(I,J)=SU
0082      CALL RWNDF(IB)
0083  300      CONTINUE
0084  C      CREAT ERROR MATRIX
0085      CALL INIT(E)
0086      CALL ENDIO
0087      DO 500 I=1,P
0088      DO 501 J=1,P
0089      SU=0.D0
0090      DO 600 K=1,R
0091      DO 600 L=1,C
0092      READ(8,51) (X(I1),I1=1,P)
0093      SU=SU+X(I)*X(J)
0094  600      CONTINUE
0095      REWIND 8
0096      CALL ENDIO
0097  501      E(I,J)=RIJ(I,J)-SU/N
0098  500      CONTINUE
0099      IF(IPT.NE.1) GO TO 564
0100      WRITE(IUNIT,565)
0101  565      FORMAT(///,5X,"ERROR MATRIX")
0102      DO 156 I=1,P

```

```

0103      WRITE(IUNIT,52) I
0104 156   WRITE(IUNIT,53) (E(I,J),J=1,P)
0105 564   REWIND 8
0106      CALL RWNDF(18)
0107      CALL INIT(RIJ)
0108      DO 101 I=1,30
0109 101    G(I)=0.00
0110      DO 100 I=1,R
0111      DO 100 J=1,C
0112      DO 100 K=1,N
0113      CALL READF(18,IER,IBUF)
0114      CALL CODE
0115      READ(IBUF,IFMT) (X(I1),I1=1,P)
0116      DO 100 L=1,P
0117      G(L)=G(L)+X(L)
0118      RIJ(I,L)=RIJ(I,L)+X(L)
0119 100     CONTINUE
0120      IF(IPT1.NE.1) GO TO 36
0121      WRITE(IUNIT,37)
0122 37     FORMAT(///,"      ROW TREATMENT TOTALS",//)
0123      DO 110 I=1,R
0124      WRITE(IUNIT,52) I
0125 52     FORMAT(5X,"ROW # ",I5)
0126 110    WRITE(IUNIT,53) (RIJ(I,J),J=1,P)
0127 53     FORMAT(4(4X,D16.11))
0128 36     RN=R*N
0129      CN=C*N
0130      RCN=R*C*N
0131      CALL ENDIO
0132      DO 200 I=1,P
0133      DO 200 J=1,P
0134      SU=0.00
0135      DO 202 K=1,R
0136 202    SU=SU+RIJ(K,I)*RIJ(K,J)
0137      SU=SU/CN-G(I)*G(J)/RCN
0138      WRITE(8,511) SU
0139 511    FORMAT(D20.13)
0140 200    CONTINUE
0141      CALL RWNDF(18)
0142      REWIND 8
0143      CALL ENDIO
0144      DO 203 I=1,P
0145      DO 203 J=1,P
0146      READ(8,511) RIJ(I,J)
0147 203    RIJ(I,J)=RIJ(I,J)+E(I,J)
0148      CALL HINV(RIJ,P,DET2)
0149      CALL INIT(RIJ)
0150      DO 92 I=1,R
0151      DO 92 J=1,C
0152      DO 92 K=1,N
0153      CALL READF(18,IER,IBUF)
0154      CALL CODE
0155      READ(IBUF,IFMT) (X(I1),I1=1,P)
0156      DO 92 L=1,P
0157 92     RIJ(J,L)=RIJ(J,L)+X(L)
0158      IF(IPT1.NE.1) GO TO 38

```

```

0159      WRITE(IUNIT,35)
0160 35    FORMAT(///,5X,"COLUMN TREATMENT TOTALS",///)
0161      DO 210 I=1,C
0162      WRITE(IUNIT,39) I
0163 39    FORMAT(5X,"COLUMN",I7)
0164 210   WRITE(IUNIT,53) (RIJ(I,J),J=1,P)
0165 38    DO 94 I=1,P
0166      DO 94 J=1,P
0167      SU=0.D0
0168      DO 95 K=1,C
0169 95    SU=SU+RIJ(K,I)*RIJ(K,J)
0170      SU=SU/RN-G(I)*G(J)/RCH
0171      WRITE(8,511) SU
0172 94    CONTINUE
0173      CALL RWNDF(IB)
0174      REWIND 8
0175      J2=P*P
0176      CALL ENDIO
0177      DO 912 I=1,J2
0178 912   READ(8,511) SU
0179      DO 99 I=1,P
0180      DO 99 J=1,P
0181      READ(8,511) RIJ(I,J)
0182 99    RIJ(I,J)=RIJ(I,J)+E(I,J)
0183      REWIND 8
0184      CALL MINV(RIJ,P,DET3)
0185      CALL INIT(RIJ)
0186      SUB H1,H2,E FROM TOTAL GET HE STORE IN TIJ
0187      DO 3000 I=1,P
0188      DO 3000 J=1,P
0189      SU=0.D0
0190      DO 4000 L3=1,R
0191      DO 4000 L1=1,C
0192      DO 4000 L2=1,H
0193      CALL READF(IB,IER,IBUF)
0194      CALL CODE
0195      READ(IBUF,IFMT) (X(I1),I1=1,P)
0196 4000   SU=SU+X(I)*X(J)
0197      RIJ(I,J)=SU-G(I)*G(J)/RCH
0198      CALL RWNDF(IB)
0199 3000   CONTINUE
0200      CALL CLOSE(IB)
0201      CALL ENDIO
0202      DO 1001 I1=1,2
0203      DO 1001 I=1,P
0204      DO 1001 J=1,P
0205      READ(8,511) X(1)
0206 1001   RIJ(I,J)=RIJ(I,J)-X(1)
0207      CALL MINV(RIJ,P,DET1)
0208      CALL MINV(E,P,DETE)
0209      DET1=DETE/DET1
0210      DET2=DETE/DET2
0211      DET3=DETE/DET3
0212 C     DET1,DET2,DET3 CONTAIN U -STATISTIC FOR H1,H2,H3 HYPOTH

```



```

0213      J1=R-1
0214      J2=C-1
0215      J3=J1*J2
0216      K=R*C*(N-1)
0217  C    DFARE P,J(I),K
0218      WRITE(IUNIT,409) DET1,P,J1,K,DET2,P,J2,K,DET3,P,J3,K
0219  409   FORMAT(//,10X,"HYPOTHESIS TEST RESULTS",//,5X,"HYPOTHESIS OF ",
0220          $10X,"U-STATISTIC",10X,"DEGREES OF FREEDOM",//,5X,
0221          $1"INTERACTION EFFECT ",5X,D16.11,5X,3I7,/,5X,"FACTOR A EFFECT",
0222          $26X,D16.11,5X,3I7,/,5X,"FACTOR B EFFECT",8X,D16.11,5X,3I7)
0223  C    PLACE FPROB HERE IN WANTED
0224      END
0225      SUBROUTINE ENDIO
0226  C    SUB. TO WAIT UNTIL TAPE IS FREE
0227  10    CALL EXEC(13,108,I1,I2,I3)
0228          IF(I1.LT.0) GO TO 10
0229      RETURN
0230      END
0231      SUBROUTINE INIT(RIJ)
0232      DOUBLE PRECISION RIJ(30,30)
0233      DO 10 I=1,30
0234      DO 10 J=1,30
0235  10      RIJ(I,J)=0.00
0236      RETURN
0237      END
0238      END$

```

D. Regression and Factor Analysis

SREGR (Simple Linear Regression)

Purpose:

This program performs a simple linear regression, and provides an ANOVA goodness of fit which tests the aptness of the model.

Mathematical Model:

The model for the regression analysis is:

$$Y_i = b_0 + b_1 x_i$$

where:

$i = 1$ to N , the number of observations

User Considerations and Procedures:

1. Program expects a data file to be created (see DA30) with N records. Each record has two variables, X and Y , which are arranged in that order.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of observations (maximum 32767)
 - b. name of data file
 - c. format of data file
5. Printout gives:
 - a. raw data (optional)
 - b. $\bar{X}$ and $\bar{Y}$
 - c. estimated value of B_0 and B_1
 - d. ANOVA source table
 - e. R value
 - f. standard error of B_0 and B_1

Test Data:

This program was tested using data from John Neter and William Wasserman, Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Design, Richard D. Irwin, Inc., 1974, P. 93. The program uses double precision.

RU,SREGR
SIMPLE REGRESSION, $Y=B_0 + B_1 \cdot X$
DATA ENTER AS X THEN Y
ENTER NAME OF FILE FROM DA30
#SREGR
ENTER FORMAT OF DATA
(2(3X,F5.1))
ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0
1
ENTER 1 FOR CRT DISPLAY, 6 FOR LINEPRINTER
6
ENTER IN NUMBER OF OBSERVATIONS
10
:

RAW DATA

X	Y
30.0	73.0
20.0	50.0
60.0	128.0
80.0	170.0
40.0	87.0
50.0	108.0
60.0	135.0
30.0	69.0
70.0	148.0
60.0	132.0

BAF = 50.0000 YBAR = 110.0000

B0 = 10.00000000

B1 = 2.00000000

SOURCE	SS	DF	MS	F	P(F)
MODEL	13600.0000	1	13600.0000	1813.3333	.000003
ERROR	60.0000	8	7.5000		
TOTAL	13660.0000	9			

R = .997801

STANDARD ERROR OF B0 = 2.50294

STANDARD ERROR OF B1 = .14852

"SREGR T=00003 IS ON CR00002 USING 00012 BLKS R=0000

```

0001 FTH4
0002     PROGRAM SREGR
0003     REAL MSE,MSR
0004     DOUBLE PRECISION X,Y,SUMX,SUMY,SUMX2,SUMY2,SUMXY,R,B0,
0005     B1,DEN,XN,SX,SY,SXY,SSTO,SSE,MSE,MSR,SB0,SB1
0006     DIMENSION IB(144),IBUF(128),NAME(3),IFMT(20)
0007     WRITE(1,10)
0008 10    FORMAT("SIMPLE REGRESSION, Y=B0 + B1*X")
0009     WRITE(1,11)
0010 11    FORMAT("ENTER NAME OF FILE FROM DA30")
0011     READ(1,12) NAME
0012 12    FORMAT(3A2)
0013     WRITE(1,13)
0014 13    FORMAT("ENTER FORMAT OF DATA")
0015     READ(1,14) IFMT
0016 14    FORMAT(20A2)
0017     CALL OPEN(IB,IER,NAME,3,0,-2,128)
0018     IF(IER.GE.0) GO TO 20
0019     WRITE(1,15) NAME,IER
0020 15    FORMAT(3A2,"FAILED TO OPEN , IER = ",I5)
0021     STOP 15
0022 20    WRITE(1,16)
0023 16    FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA,ELSE ENTER 0")
0024     READ(1,*) IPTO
0025     WRITE(1,18)
0026 18    FORMAT("ENTER 1 FOR CRT DISPLAY, 6 FOR LINEPRINTER")
0027     READ(1,*) IUNIT
0028     WRITE(1,17)
0029 17    FORMAT("ENTER IN NUMBER OF OBSERVATIONS")
0030     READ(1,*) N
0031     IF(IPTO.EQ.1) WRITE(IUNIT,99)
0032 99    FORMAT(" RAW DATA  "/", "      X      Y      "/)
0033     DO 30 I=1,N
0034     CALL READF(IB,IER,IBUF)
0035     CALL CODE
0036     READ(IBUF,IFMT) X,Y
0037     IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) X,Y
0038     SUMX=SUMX+X
0039     SUMY=SUMY+Y
0040     SUMX2=SUMX2+X*X
0041     SUMY2=SUMY2+Y*Y
0042 30    SUMXY=SUMXY+X*Y
0043     XN=N
0044     DEN=XN*SUMX2-SUMX*SUMX
0045     B0=(SUMY*SUMX2-SUMX*SUMXY)/DEN
0046     B1=(XN*SUMXY-SUMX*SUMY)/DEN
0047     XBAR=SUMX/XN
0048     YBAR=SUMY/XN

```

```

0049      SXY=SUNXY-SUMX*SUNY/XN
0050      SX=SUNX2-SUMX*SUNX/XN
0051      SY=SUNY2-SUNY*SUNY/XN
0052      R=SXY/DSQRT(SX*SY)
0053      R=SXY/DSQRT(SX*SY)
0054      SSTO=SUNY2-XN*YBAR*YBAR
0055      SSE=SUNY2-B0*SUNY-B1*SUNXY
0056      MSR=SSTO-SSE
0057      MSE=SSE/(XN-2.)
0058      F=MSR/MSE
0059      DF1=1
0060      DF2=N-2
0061      CALL FPROB(F,DF1,DF2,Z,P)
0062      SB0=DSQRT(MSE*(1./XN+XBAR*XBAR/SX))
0063      SB1=DSQRT(MSE/SX*XN)
0064      WRITE(IUNIT,190) XBAR,YBAR
0065 190    FORMAT(//,"XBAR = ",F10.4,"    YBAR = ",F10.4,//)
0066      WRITE(IUNIT,908) B0,B1
0067 908    FORMAT(" B0 = ",F14.8,/, " B1 = ",F14.8/)
0068      WRITE(IUNIT,100)
0069 100    FORMAT(//"SOURCE",8X,"SS",10X,"DF",10X,"MS",10X,"F",10X,
0070      C"P(F)"//)
0071      DF3=DF1+DF2
0072      SSR=MSR
0073      WRITE(IUNIT,110) SSR,DF1,MSR,F,P,SSE,DF2,MSE,SSTO,DF3
0074 110    FORMAT(" MODEL",5X,F10.4,3X,F5.0,2(3X,F10.4),3X,F10.6,/" ERROR"
0075      $,5X,F10.4,3X,F5.0,3X,F10.4,/" TOTAL",5X,F10.4,3X,F5.0)
0076      WRITE(IUNIT,120) R,SB0,SB1
0077 120    FORMAT(//," R = ",F10.6,/" STANDARD ERROR OF B0 = ",F10.5,/,
0078      $" STANDARD ERROR OF B1 = ",F10.5)
0079      CALL CLOSE(IUNIT)
0080      END
0081      END$

```


SRM30 (Correlation Matrix)

Purpose:

This program creates a correlation matrix from raw data. The matrix is required for the factor analysis (FATAA) and multiple regression (MRMAIN) programs.

User Considerations and Procedures:

1. A matrix data file must be created with n point per record.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. The correlation matrix can be saved in the file SRDATA. This matrix is necessary for FATAA and/or MRMAIN. To save this matrix, enter 1 for yes, 0 for no.
4. Parameters required:
 - a. number of variables (maximum 30)
 - b. name, format, and record length of data file (see 0A30)
 - c. number of subjects (maximum 32767)
 - d. names of the n variables (maximum 8 characters per name, one name per line)
 - e. scratch file name - do not use the same SCRTCH. This file is a working file and is destroyed upon completion of SRM30.
 - f. number of variables per line for output
5. Printout gives:
 - a. number of variables
 - b. number of subjects
 - c. two-tailed significance level
 - d. $\bar{X}$, SD, name of each variable
 - e. correlation matrix

Comments:

Whenever the option to save the correlation matrix is specified, the previous content in the SRDATA file is destroyed. Therefore, FATAA and/or MRMAIN should be run before using SRM30 again in order to preserve the data files. If this cannot be done, save the contents of SRDATA in another file. It will be necessary to dump the preserved data file into SRDATA before FATAA and/or MRMAIN analyses are done.

Test Data:

This program was tested using data presented on the next page. The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to six digit places instead of ten digits.

Variables

Subject	1	2	3	4	5	6	7	8
0001	24.00	81.00	992.00	1024.0	978.00	1101.0	936.00	1120.0
0002	25.00	22.00	181.00	310.00	293.00	346.00	188.00	166.00
0003	27.00	57.00	124.00	172.00	166.00	491.00	154.00	83.00
0004	29.00	36.00	553.00	719.00	605.00	833.00	585.00	346.00
0005	30.00	54.00	1046.0	2221.0	1841.0	2656.0	1062.0	1030.0
0006	31.00	25.00	322.00	522.00	402.00	676.00	261.00	379.00
0007	32.00	78.00	838.00	364.00	222.00	433.00	1014.0	584.00
0008	35.00	80.00	575.00	405.00	456.00	320.00	789.00	320.00
0009	36.00	30.00	835.00	811.00	716.00	824.00	735.00	975.00
0010	37.00	80.00	1001.0	166.00	179.00	154.00	907.00	1065.0
0011	37.00	57.00	1418.0	1706.0	1656.0	1759.0	1024.0	219.00
0012	45.00	74.00	531.00	503.00	581.00	593.00	481.00	593.00
0013	77.00	66.00	218.00	637.00	681.00	591.00	300.00	201.00
0014	80.00	47.00	133.00	109.00	112.00	106.00	166.00	108.00
0015	80.00	80.00	74.00	100.00	115.00	90.00	79.00	68.00
0016	80.00	74.00	550.00	322.00	422.00	204.00	600.00	400.00
0017	18.00	61.00	72.00	429.00	456.00	411.00	405.00	856.00
0018	19.00	18.00	67.00	760.00	856.00	509.00	966.00	3216.0
0019	20.00	80.00	173.00	434.00	311.00	511.00	103.00	139.00
0020	20.00	15.00	209.00	422.00	573.00	250.00	230.00	110.00
0021	22.00	29.00	18.00	1024.0	1114.0	853.00	687.00	671.00
0022	22.00	56.00	98.00	267.00	229.00	341.00	206.00	106.00
0023	22.00	7.00	21.00	752.00	795.00	491.00	1252.0	1308.0
0024	24.00	14.00	292.00	1312.0	1324.0	1296.0	1342.0	1851.0
0025	80.00	51.00	116.00	777.00	1034.0	548.00	880.00	952.00
0026	74.00	51.00	13.00	392.00	390.00	394.00	243.00	265.00
0027	64.00	46.00	19.00	318.00	292.00	348.00	156.00	134.00
0028	60.00	37.00	42.00	703.00	787.00	578.00	142.00	257.00
0029	59.00	18.00	345.00	899.00	778.00	1141.0	424.00	411.00
0030	54.00	14.00	49.00	968.00	747.00	1521.0	925.00	857.00
0031	54.00	71.00	16.00	503.00	421.00	964.00	275.00	226.00
0032	51.00	53.00	15.00	198.00	201.00	193.00	591.00	236.00
0033								
0034								

```

RU,SRM30
SRMAIN30
ENTER # DATA VARIABLES:
8
ENTER INPUT FILE NAME:
#FATAA
ENTER INPUT DATA FORMAT (SUBJ DATA ACROSS):
(8(2X,F6.2))
ENTER THE RECORD LENGTH AS IN DA30
64
ENTER # SS:
32
DESIRE TO SAVE OUTPUT FOR MR? (1=YES, 0=NO):
1
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
ENTER VARIABLE NAMES (MAX 8 CHARACTERS EACH):
A
B
C
D
E
F
G
H
ENTER NAME OF SCRATCH FILE.
IF YOU ARE CONSIDERING NAMING YOUR SCRATCH FILE 'SCRATCH'
PLEASE NOTE THAT THE PRINCIPAL FACTORS PROGRAM FATAA
ESTABLISHES A FILE WITH SUCH A NAME FOR USE IN THAT PARTI-
CULAR PROGRAM. IN ORDER TO SAVE YOURSELF SOME TIME OR TO
AVOID ERRORS (IF YOU INTEND TO USE FATAA) IT IS TO YOUR
BENEFIT NOT TO NAME THIS FILE 'SCRATCH.'
SCRATCH FILE NAME =
HELLO

ENTER # VBS. PER PAGE FOR OUTPUT:
8

```

SRM30 IS NOW FINISHED

:

NUMBER OF VARIABLES = 8
 NUMBER OF SUBJECTS = 32

TWO-TAILED SIGNIFICANCE LEVELS

P = .050 P = .010 P = .005 P = .001
 .29635 .35203 .46338 .59090

VB	MEAN	SD	
1	42.750	21.350	A
2	48.812	23.575	B
3	342.375	374.970	C
4	632.781	457.059	D
5	616.656	422.742	E
6	672.687	534.885	F
7	565.875	370.204	G
8	601.625	636.181	H

	1	2	3	4	5	6	7	8
1	1.0000	.2301	-.2057	-.2388	-.2014	-.2070	-.3045	-.3451
2	.2301	1.0000	.3379	-.2689	-.2920	-.1948	-.1690	-.3307
3	-.2057	.3379	1.0000	.4819	.4241	.4659	.4920	.0846
4	-.2388	-.2689	.4819	1.0000	.9689	.9375	.6105	.3755
5	-.2014	-.2920	.4241	.9689	1.0000	.8408	.6300	.4281
6	-.2070	-.1948	.4659	.9375	.8408	1.0000	.4869	.2326
7	-.3045	-.1690	.4920	.6105	.6300	.4869	1.0000	.6872
8	-.3451	-.3307	.0846	.3755	.4281	.2326	.6872	1.0000

*SRM30 T=00004 IS UN CR00002 USING 00025 BLKS R=0199

```

0001 FTH4
0002 PROGRAM SRM30
0003 INTEGER XNAME
0004 DOUBLE PRECISION XBAR(30), SIG(3^), R(30,60), X(30)
0005 DOUBLE PRECISION VAR
0006 DIMENSION IB(272), IC(272), ID(272), IDUF(256)
0007 DIMENSION ISIZE(2), IA(3), NAMA(3), NAMB(3)
0008 DIMENSION XNAME( 0,4), INFILE(3), IFMT(20), ISCTCH(3)
0009 COMMON XBAR, SIG, R, X, VAR
0010 DATA IA/2HSR,2HDA,2HTA/
0011 DATA NAMA/2HMR,2HM3,1H0/
0012 DATA NAMB/2HFA,2HTA,1HA/
0013 WRITE(1,4400)
0014 4400 FORMAT ( "&SRMAIN30" )
0015 WRITE(1,4401)
0016 4401 FORMAT ( "&ENTER # DATA VARIABLES: " )
0017 READ(1,*) L
0018 WRITE(1,4402)
0019 4402 FORMAT ( "&ENTER INPUT FILE NAME: " )
0020 READ(1,2) INFILE
0021 2 FORMAT(3A2)
0022 WRITE(1,4406)
0023 4406 FORMAT ( "&ENTER INPUT DATA FORMAT (SUBJ DATA ACROSS): " )
0024 READ(1,231) IFMT
0025 231 FORMAT(20A2)
0026 WRITE(1,88)
0027 88 FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0028 READ(1,*) LENGTH
0029 LEN=LENGTH/2
0030 IF((LEN*2).NE.LENGTH) LEN=LEN+1
0031 LENGTH=LEN
0032 IDCBS=LENGTH
0033 IF(LENGTH.LT.144) IDCBS=144
0034 WRITE(1,4403)
0035 4403 FORMAT ( "&ENTER # SS: " )
0036 READ(1,*) KNT
0037 WRITE(1,4404)
0038 4404 FORMAT ( "&DESIRE TO SAVE OUTPUT FOR MR? (1=YES; 0=NO): " )
0039 READ(1,*) NPCH
0040 25 WRITE(1,4405)
0041 4405 FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: " )
0042 READ(1,*) IUNIT
0043 IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 25
0044 IF(NPCH.LE.0)GO TO 27
0045 27 CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
0046 IF(IER.GE.0) GO TO 800
0047 WRITE(1,801) INFILE,IER
0048 801 FORMAT(" NO OPEN DATA FILE ",3A2," IER = ",I5)
0049 STOP 701

```

```

0050 800 DO 5 K=1,30
0051 XBAR(K)=0
0052 SIG(K)=0
0053 DO 275 I=1,4
0054 275 XNAME(K,I)=0
0055 DO 5 J=1,60
0056 5 R(K,J)=0
0057 WRITE(1,4407)
0058 4407 FORMAT ( "ENTER VARIABLE NAMES (MAX 8 CHARACTERS EACH): " )
0059 DO 19 I=1,L
0060 READ(1,4)(XNAME(I,J),J=1,4)
0061 4 FORMAT(4A2)
0062 19 CONTINUE
0063 NS=0
0064 WRITE(1,4408)
0065 4408 FORMAT ( "ENTER NAME OF SCRATCH FILE." )
0066 WRITE(1,4409)
0067 4409 FORMAT ("IF YOU ARE CONSIDERING NAMING YOUR SCRATCH FILE",
0068 1" 'SCRATCH " )
0069 WRITE(1,4410)
0070 4410 FORMAT("PLEASE NOTE THAT THE PRINCIPAL FACTORS PROGRAM FATAA")
0071 WRITE(1,4411)
0072 4411 FORMAT (" ESTABLISHES A FILE WITH SUCH A NAME FOR USE",
0073 2" IN THAT PAR-" )
0074 WRITE(1,4412)
0075 4412 FORMAT(" TICALAR PROGRAM. IN ORDER TO SAVE YOURSELF SOME TIME")
0076 WRITE(1,4413)
0077 4413 FORMAT (" OR TO AVOID ERRORS (IF YOU INTEND TO USE FATAA) IT")
0078 WRITE(1,4414)
0079 4414 FORMAT(" IS TO YOUR BEHEFIT NOT TO NAME THIS FILE 'SCRATCH'." )
0080 WRITE(1,4415)
0081 4415 FORMAT ( " SCRATCH FILE NAME= " )
0082 READ(1,2)ISCTCH
0083 ISIZE(2)=LENGTH
0084 XSU=KNT
0085 SIZE=LENGTH
0086 SIZE=XSU*SIZE/128. + 1.
0087 ISIZE(1)=SIZE
0088 CALL CREAT(IC,IER,ISCTCH,ISIZE,2,0,-2,IDCBS)
0089 IF(IER.GE.0) GO TO 810
0090 WRITE(1,809) ISCTCH,IER
0091 809 FORMAT(" NO OPEN SCRATCH FILE ",3A2," IER = ",15)
0092 CALL CLOSE(IB)
0093 STOP 702
0094 810 DO 11 JM=1,KNT
0095 CALL READF(IB,IER,IDUF)
0096 CALL CODE
0097 READ(IDUF,IFMT)(X(I),I=1,L)
0098 NS=NS+1
0099 DO 7 J=1,L
0100 7 XBAR(J)=XBAR(J)+X(J)
0101 CALL CODE
0102 WRITE(IDUF,IFMT)(X(J),J=1,L)
0103 CALL WRITF(IC,IER,IDUF)
0104 11 CONTINUE
0105 CALL CLOSE(IC)
0106 DO 9 J=1,L

```

```

0107 9      XBAR(J)=XBAR(J)/NS
0108      CALL OPEN(IC,IER,ISCTCH,3,0,-2,IDCBS)
0109      IF(IER.GE.0) GO TO 820
0110      WRITE(1,801) ISCTCH,IER
0111      CALL CLOSE(IB)
0112      STOP 763
0113 820     DO 1400 J=1,NS
0114         CALL READF(IC,IER,IDUF)
0115         CALL CODE
0116         READ(IDUF,IFMT)(X(J),J=1,L)
0117         DO 1400 J=1,L
0118             DO 1400 K=1,L
0119 1400     R(J,K)=R(J,K)+(X(J)-XBAR(J))*(X(K)-XBAR(K))
0120         CALL CLOSE(IC)
0121         DO 1401 J=1,L
0122             VAR=R(J,J)/NS
0123             IF(VAR.EQ.0.0)GO TO 1408
0124             SIG(J)=DSQRT(VAR)
0125             GO TO 1401
0126 1408     SIG(J)=0.0
0127 1401     CONTINUE
0128         DO 1402 J=1,L
0129             DO 1402 K=J,L
0130                 R(J,K)=R(J,K)/NS
0131                 IF(SIG(J)*SIG(K).NE.0.0)GO TO 1406
0132                 R(J,K)=0
0133             GO TO 1407
0134 1406     R(J,K)=R(J,K)/(SIG(J)*SIG(K))
0135 1407     R(K,J)=R(J,K)
0136 1402     CONTINUE
0137         WRITE(IUNIT,98) L,NS
0138 98      FORMAT(" NUMBER OF VARIABLES = ",I3/
0139             * " NUMBER OF SUBJECTS = ",I5)
0140         SS=NS
0141         SE=1./SQRT(SS-1)
0142         SA=1.65*SE
0143         SB=1.96*SE
0144         SC=2.58*SE
0145         SD=3.29*SE
0146         IF(NPCH.LE.0)GO TO 91
0147         CALL OPEN(ID,IER,IA,3,0,-2,256)
0148         IF(IER.GE.0) GO TO 840
0149         WRITE(1,801) IA,IER
0150         CALL CLOSE(IB)
0151         CALL CLOSE(IC)
0152         STOP 740
0153 840     DO 802 J2=1,60
0154         CALL CODE
0155         WRITE(IDUF,94)(R(J1,J2),J1=1,30)
0156 94      FORMAT(30(2X,F10.4))
0157         CALL WRITF(ID,IER,IDUF)
0158 802     CONTINUE
0159         CALL CODE
0160         WRITE(IDUF,94) XBAR
0161         CALL WRITF(ID,IER,IDUF)
0162         CALL CODE

```



```

0163      WRITE(IDUF,94) SIG
0164      CALL WRITEF(ID,IER,IDUF)
0165      CALL CODE
0166      WRITE(IDUF,808) ((XNAME(I,I2),I2=1,4),I1=1,30)
0167      CALL WRITEF(ID,IER,IDUF)
0168 808    FORMAT(30(4X,4A2))
0169 91     WRITE(IUNIT,13)
0170 13     FORMAT(/"          VB.      MEAN      SD")
0171      DO 14 I=1,L
0172 14     WRITE(IUNIT,15)I,XBAR(I),SIG(I),(XNAME(I,J),J=1,4)
0173 15     FORMAT(9X,I3,2F10.3,10X,4A2)
0174 100    WRITE(1,4416)
0175 4416   FORMAT ( " " )
0176 101    WRITE(1,4417)
0177 4417   FORMAT ( "ENTER # VBS. PER PAGE FOR OUTPUT: " )
0178      READ(1,*) NPAGE
0179      IF(NPAGE.GT.L)GO TO 101
0180      NPX=NPAGE-1
0181      KM=((L-1)/NPAGE+1)*NPAGE
0182      DO 995 M=NPAGE,KM,NPAGE
0183      LM=M-NPX
0184      IF(M-KM)937,996,997
0185 996     M=L
0186 997     WRITE(IUNIT,910)(I,I=LA,M)
0187 910    FORMAT(/7X,10(I10,1X))
0188      DO 995 I=1,L
0189 995     WRITE(IUNIT,930)I,(R(I,J),J=LA,M)
0190 930     FORMAT(15,F13.4,1X,9(F10.4,1X))
0191 931     WRITE(1,4418)
0192 4418   FORMAT(///,"SRM30 IS NOW FINISHED")
0193      CALL CLOSE(IB)
0194      CALL CLOSE(IC)
0195      CALL CLOSE(ID)
0196      CALL PURGE(ID,IER,ISCTCH)
0197      STOP
0198      END
0199      END$

```

MRMAIN (Multiple Regression Analysis)

Purpose:

This program performs a multiple regression analysis, arriving at a final equation using a forward stepwise procedure based on a maximum R-squared and F-test criteria.

Mathematical Model:

The model for the regression analysis is:

$$Y_i = B_0 + B_1X_{1i} + B_2X_{2i} + \dots B_jX_{ji} + E_i$$

where:

Y_i = ith observation of dependent variables

X_{ji} = ith observation of the jth independent variable

B_j = regression coefficient

E_i = normally distributed error term

User Considerations and Procedures:

1. Program requires input from SRM30. MRMAIN reads the file SRDATA created by SRM30 to receive the correlation matrix, variable means, standard deviation, and variable names.
2. Initial options and parameters:
 - a. option for device output; enter 6 for line printer or 1 for CRT
 - b. enter number of variables from SRM30 (maximum 30)
 - c. enter the number of subjects on which correlation matrix is based
 - d. enter number of the dependent variable (as entered in SRM30)
 - e. enter minimum acceptable F for inclusion in equation - standard or typical value is 1
 - f. enter the number of variables excluded from model, and those forced in model. If none are excluded, enter 0. If none are forced, enter 0

- 1) if the number excluded is not 0, program asks which variables are to be excluded. Enter the variable numbers of those to be excluded. These can be entered in any order separated by commas.
 - 2) If the number forced is not 0, program asks how the variables are to be forced in the equation. Enter the variable numbers of the forced variables in the order they are to be forced. Separate the variables numbers by commas. (NOTE: forcing variables that are highly correlated to each other will cause stability problems.)
- g. enter number of this equation - enter 1, usually
- h. enter number of additional composites desired
- i. in the following options, enter 1 for yes, 0 for no:
- 1) suppress weight reversals (0 forces $B_j \geq 0$)
 - 2) multiply weights by 1000
 - 3) set mean of predicted scores - if 1, program then asks you to enter the mean
 - 4) set standard deviation of predicted score - if 1, program asks you to enter the standard deviation
 - 5) check parameters, enter 1 if they are correct or 0 to restart
- v
2. Options for storing data in order to plot the residuals: Enter 1 to plot residuals, 0 otherwise. (NOTE: If 1 is entered a scratch tape must be mounted. Residuals are outputted to magnetic tape as Y-criterion, Y-predicted in a (2(5X,F10.3)) format. To plot residuals run the program RESID. When this option is used, the name of raw data file and format of file is required.)
 3. Printout gives:
 - a. copy of desired initial options and parameters
 - b. listing of variable names and corresponding $\bar{X}$, and standard deviation
 - c. as each variable is entered into the model the following information is given: number entered, variable numbers, cumulative multiple R, cumulative multiple R increase by this variable, R-square, shrunken R-squared, F-value for entering into model, degrees of freedom and probability of the F-value, and name of variable entered

- d. after each variable is entered, the following information is given: the number entered, the variable number, mean, standard deviation, Z-weight, raw score weight (B_j), critical R, Z-weight * critical R, and variable name
- e. B_0 or constant is printed out for each step

Comments:

The scratch file is automatically purged from the disc at end of the MRMAIN run.

Test Data:

This program was tested using data presented below. The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to five or six digit places instead of ten digits except when variables are forced into the model that are too highly correlated, (i.e., $> .99$). In those cases accuracy is less than five digit places.

Subject	Independent Variable	Dependent Variable		
		1	2	3
1	19	1	1	1
2	28	2	2	2
3	17	1	-1	5
4	42	3	4	5
5	24	1	2	3
6	1	-1	-1	-1
7	8	-1	2	3
8	16	0	3	-3

```

RU,MRMAIN
:SV,4
MRMAIN30
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
ENTER # VBS IN MATRIX (MAX 30):
4
ENTER # SS ON WHICH CORRELS BASED:
8
ENTER # OF CRIT VARIABLE:
1
ENTER MINIMUM ACCEPTABLE F FOR INCLUSION IN EQUATION:
1
ENTER # VBS EXCLUDED, & # VBS FORCED:
0,0
ENTER # OF THIS EQUATION:
1
ENTER # OF ADDITIONAL COMPOSITES DESIRED:
0
IN THE FOLLOWING DIALOG, 1 = YES, 0 = NO
SUPPRESS WT REVERSALS?
1
MULT WTS BY 1000?
0
SET MEAN OF PREDICTED CORES?
0
SET SD OF PREDICTED SCORES?
0
SUPPRESS ADDITIONAL SHRUNKEN R ESTIMATES?
0
CHECK ABOVE PARAMETERS, ENTER 1 TO CONTINUE, 0 TO RESTART:
1
ENTER NAME OF SCRATCH FILE:
TECH 1
ENTER 1 TO PLOT RESIDUALS (Y-PRED VS Y-OBS):
1
  OUTPUT FILE FOR RESIDUALS IS MAG TAPE!
ENTER RAW DATA FILE NAME:
#MRM30
ENTER RAW DATA FORMAT:
(4(4X,F10.4))
MRM30 FINISHED
MRM30 ABORTED

```

SELECTED OPTIONS

VBS = 4

SS = 8

F-VALUE = 1

WT. REVERSALS SUPPRESSED.

INPUT FILE: SRDATA

SCRATCH FILE: TECHI

VB.	MEAN	ST. DEV.	
1	19.375	11.683	Y
2	.750	1.299	X
3	1.500	1.658	F
4	1.875	2.619	G

CRIT VB 1) Y MEAN: 19.375; SIGMA: 11.683

VARIABLE ADDED: 2) (CRIT. IS NO. 1 Y)

N.	VB.	CUM MULT R	INCREASE	R-SQUARE	SHRNKN R	F-VALUE	DF=1 &	PROB(F)
1	2	.961600	.961600	.924675	.955050	73.6543	6	.00039

CORRECTED SHRUNKEN R ESTIMATES: .943 .939; CUM ERROR PROB: .000388

N	VB.	MEAN	SIGMA	Z-WEIGHT	RAW SCR WT	CRIT R	Z-WT*CRIT R
1	2	.750	1.299	.96160	8.64825	.96160	.92467 X
CONSTANT: 12.889							

VARIABLE ADDED: 3) (CRIT. IS NO. 1 Y)

N	VB.	CUM MULT R	INCREASE	R-SQUARE	SHRNKN R	F-VALUE	DF=1 &	PROB(F)
2	3	.995407	.033807	.990835	.993564	36.0956	5	.00256

CORRECTED SHRUNKEN R ESTIMATES: .992 .989; CUM ERROR PROB: .002946

N	VB.	MEAN	SIGMA	Z-WEIGHT	RAW SCR WT	CRIT R	Z-WT*CRIT R
1	2	.750	1.299	.82680	7.43588	.96160	.79505 X
2	3	1.500	1.658	.29040	2.04587	.67420	.19579 F
CONSTANT: 10.729							

VARIABLE ADDED: 4)(CRIT. IS NO. 1 Y).									
N	VB.	CUM MULT R	INCREASE	R-SQUARE	SHRNKN R	F-VALUE	DF=1 &	PROB(F)	
3	4	.997799	.002392	.995603	.996145	4.3379	4	.10515	

CORRECTED SHRUNKEN R ESTIMATES: .995 .991; UM ERROR PROB: .107785

FINAL EQUATION:

N	VB.	MEAN	SIGMA	Z-WEIGHT	RAW SCR WT	CRIT R	Z-WT*CRIT R	
1	2	.750	1.299	.76987	6.92390	.96160	.74031	X
2	3	1.500	1.658	.31313	2.20600	.67420	.21111	F
3	4	1.875	2.619	.08558	.38175	.51630	.04419	G

CONSTANT: 10.157

INPUT RAW DATA FILE: #MRM30
 INPUT DATA FORMAT: (4(4X,F10.4))
 RESIDUALS OUTPUT TO TAPE:
 (CRITERION, Y-PREDICTED 2(5X,F10.3) FORMAT)

MRMAIN T=00004 :S ON CR00002 USING 00001 BLKS R=0005

0001 :SV,4
0002 :RP,MRM30
0003 :RU,MRM31
0004 :OF,MRM30
0005 :SV,1

*MRM30 T=00004 IS ON CR00002 USING 00040 BLKS R=0325

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0001 FTH4
0002     PROGRAM MRM30
0003     COMMON IUNIT,MINC,IFIN,L,N,NC,FVAL,NEX,NFRCE,NTIME,HRPT,
0004 $NPOS,MULT,ICOM,TMN,TSIG,NSHR,AL,NPASS,ICOMM,NFA
0005     COMMON IRDFIL(3),IRFMT(20),RDATA(30)
0006     INTEGER RFMT(20),XNAME
0007     COMMON ISIZE(2),INFILE(3),IFMT(20)
0008     COMMON SGH(30),KFRCE(30),WT(30),KKX(30)
0009     COMMON X(60),NX(30)
0010     COMMON K(30,60),SIG(30),XBAR(30),XNAME(30,4)
0011     COMMON IB(272),IBUF(256)
0012     DIMENSION ISRD(3)
0013     DATA ISRD/2HSR,2HDA,2HTA/
0014 1000 IF(NTIME.GT.1)GO TO 4000
0015 3000 CALL OPEN(IB,IER,ISRD,3,0,-2,256)
0016     IF(IER.GE.0) GO TO 3010
0017     WRITE(1,4420) IER
0018 4420 FORMAT ( 'NO OPEN SRDATA, IER = ',15 )
0019     STOP 4420
0020 3010 WRITE(IUNIT,3020)
0021 3020 FORMAT(' INPUT FILE: SRDATA')
0022     DO 4421 IJ=1,60
0023     CALL READF(IB,IER,IBUF)
0024     CALL CODE
0025     READ(IBUF,94) (R(JI,IJ),JI=1,30)
0026 94     FORMAT(30(2X,F10.4))
0027 4421 CONTINUE
0028     CALL READF(IB,IER,IBUF)
0029     CALL CODE
0030     READ(IBUF,94) XBAR
0031     CALL READF(IB,IER,IBUF)
0032     CALL CODE
0033     READ(IBUF,94) SIG
0034     CALL READF(IB,IER,IBUF)
0035     CALL CODE
0036     READ(IBUF,808) ((XNAME(I1,I2),I2=1,4),I1=1,30)
0037 808     FORMAT(30(4X,4A2))
0038     CALL CLOSE(IB)
0039 3150 IF(NTIME.GT.0)GO TO 4000
0040     IF(HRPT.LE.0)GO TO 4000
0041     NTIME=1
0042 4000 CONTINUE
0043     EWP=1
0044     IG1=NFRCE
0045     IG2=NFA
0046     IG3=NEX
0047     IF(NTIME.NE.1)GO TO 4080
0048     WRITE(1,4430)
0049 4430 FORMAT ( 'ENTER NAME OF SCRATCH FILE:' )
0050     READ(1,3071)INFILE

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0051      ISIZE(1)=73
0052      ISIZE(2)=150
0053      CALL CREAT(IB,IER,INFILE,ISIZE,2,0,-2,150)
0054      IF(IER.GE.0)GO TO 4030
0055      WRITE(1,4431) IER
0056 4431   FORMAT ( 'NO OPEN SCRATCH FILE, IER = ',15 )
0057      STOP 4431
0058 4030   IF(IUNIT.EQ.6)WRITE(IUNIT,4040)INFILE
0059 4040   FORMAT(' SCRATCH FILE: ',3A2)
0060      CALL CODE
0061      WRITE(IBUF,22) XBAR
0062 22      FORMAT(30F10.4)
0063      CALL WRITF(IB,IER,IBUF)
0064      CALL CODE
0065      WRITE(IBUF,22) SIG
0066      CALL WRITF(IB,IER,IBUF)
0067      DO 4070 I=1,60
0068      CALL CODE
0069      WRITE(IBUF,22) (R(J,I),J=1,30)
0070 4070   CALL WRITF(IB,IER,IBUF)
0071      CALL CLOSE(IB)
0072 4080   IF(NTIME.LT.2)GO TO 4110
0073      CALL OPEN(IB,IER,INFILE,3,0,-2,150)
0074      IF(IER.GE.0)GO TO 4090
0075      WRITE(1,4433) IER
0076 4433   FORMAT ( 'NO RE-OPEN SCRATCH FILE, IER = ',15 )
0077      STOP 4433
0078 4090   CALL READF(IB,IER,IBUF)
0079      CALL CODE
0080      READ(IBUF,22) XBAR
0081      CALL READF(IB,IER,IBUF)
0082      CALL CODE
0083      READ(IBUF,22) SIG
0084      DO 4100 I =1,60
0085      CALL READF(IB,IER,IBUF)
0086      CALL CODE
0087 4100   READ(IBUF,22) (R(J,I),J=1,30)
0088 4110   WRITE(IUNIT,4120)
0089 4120   FORMAT(//14X,' VB.          MEAN          ST. DEV. '//)
0090      KKM=NEX
0091      DO 4160 I=1,L
0092      SGH(I)=R(I,NC)
0093      IF(NEX.LE.0)GO TO 4140
0094      DO 4130 J=1,NEX
0095      KKX(J)=RX(J)
0096      NZ=NX(J)
0097      IF(I.EQ.NZ)GO TO 4160
0098 4130   CONTINUE
0099 4140   WRITE(IUNIT,4150)I,XBAR(I),SIG(I),(XNAME(I,J),J=1,4)
0100 4150   FORMAT(14X,13,5X,F10.3,5X,F10.3,5X,4A2)
0101 4160   CONTINUE
0102      IF(TMN.GT.0.)XBAR(NC)=TMN
0103      IF(TSIG.GT.0.)SIG(NC)=TSIG
0104      K=L+1
0105      NT=2*L

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0106      DO 4190 I=K,NT
0107      DO 4190 J=1,L
0108      M=J+L
0109      IF(I-M)4180,4170,4180
0110 4170   R(J,I)=-1.0
0111      GO TO 4190
0112 4180   R(J,I)=0
0113 4190   CONTINUE
0114      IF(NEX)4220,4220,42000
0115 42000  DO 4210 J=1,NEX
0116      MZ=NX(J)
0117      DO 4210 I=1,L
0118      R(MZ,I)=0.
0119 4210   R(I,MZ)=0.
0120 4220   ANA=0.
0121      OLDR=0.
0122      AN=N-1
0123      DO 4230 I=1,L
0124 4230   NX(I)=0
0125      MFR=1
0126      TS=SIG(NC)
0127      IF(MULT.LE.0)GO TO 4240
0128      IF(TSIG.GT.0.)MULT=0
0129 4240   IF(MULT.GT.0)TS=TS*1000.
0130 5000   CONTINUE
0131      WRITE(IUNIT,5020)NC,(XNAME(NC,I),I=1,4),XBAR(NC),TS
0132 5020   FORMAT("0*** CRIT VB ***",I4," " ,4A2,"MEAN: ",F10.3,
0133 $) SIGMA: ",F10.3)
0134 5030   DO 5060 I=1,L
0135      IF(R(I,I)-.001)5040,5040,5050
0136 5040   X(I)=0.
0137      GO TO 5060
0138 5050   X(I)=R(I,NC)**2)/R(I,I)
0139 5060   CONTINUE
0140      X(NC)=0.
0141      IF(MFR.GT.NFRCE)GO TO 5070
0142      M=KFRCE(MFR)
0143      MFR=MFR+1
0144      TEMP=X(M)
0145      GO TO 5020
0146 5070   IF(MPOS.LE.0)GO TO 5090
0147      DO 5080 I=1,L
0148      TEMP=R(I,NC)-SQM(I)
0149      IF(TEMP.LE.0.)X(I)=0.
0150 5080   CONTINUE
0151 5090   TEMP=X(1)
0152      M=1
0153      DO 5110 I=2,L
0154      IF(X(I)-TEMP)5110,5110,5100
0155 5100   TEMP=X(I)
0156      M=I
0157 5110   CONTINUE
0158 5120   ANA=ANA+1.
0159      NFA=NFA-1
0160      DFA=AN-AMA
0161      V=R(NC,NC)-TEMP

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0162      IF(V-.001)5130,5130,5140
0163 5130  FRAT=1000.
0164      AMA=L
0165      GO TO 5150
0166 5140  FRAT=(TEMP*DFA)/V
0167      IF(NFA.GE.0)GO TO 5150
0168      IF(FRAT-FVAL)6050,6050,5150
0169 5150  IF(R(M,M).GT.0.001)GO TO 5160
0170      V=0.
0171      GO TO 5170
0172 5160  V=1./CART(R(M,M))
0173 5170  DO 5180 I=1,NT
0174 5180  X(I)=R(M,I)*V
0175      DO 5190 I=1,L
0176      IF(X(I).EQ.0.)GO TO 5190
0177      DO 5190 J=1,NT
0178      IF(X(J).EQ.0.)GO TO 5190
0179      R(I,J)=R(I,J)-X(I)*X(J)
0180 5190  CONTINUE
0181      R(M,M)=0.
0182      RMS=R(C,NC)
0183      RKK=RMS*(AM/DFA)
0184      RSH=1.-RKK
0185      IF(NSHR.GT.0)GO TO 52000
0186      RSS5=1.-RKK*(1.+(AL/(2.*DFA)))
0187      RSS3=1.-RKK*((AM+2.)/(AM+1.))*((AM-1.)/(DFA-1.))
0188      IF(RSS5.GT.0.)RSS5=SQRT(RSS5)
0189      IF(RSS3.GT.0.)RSS3=SQRT(RSS3)
0190 52000  IF(RSH.GT.0.)RSH=SQRT(RSH)
0191      RMS=1.-RMS
0192      RM=SQRT(RMS)
0193      UP=RM-OLDR
0194      K=AMA
0195      NDF=DFA
0196      PB=1.0
0197      CALL FPROB(FRAT,PB,DFA,ZZ,PP)
0198      PPB=1.-PP
0199      EWP=EWP+PPB
0200      EWR=1.-EWP
0201      WRITE(IUNIT,6010)M,NC,(XNAME(NC,I),I=1,4)
0202 6010  FORMAT("VARIABLE ADDED: ",I3,")(CRIT. IS NO.",I3,2X,4A2,")")
0203      WRITE(IUNIT,6020)
0204 6020  FORMAT("  N.  VB.      CUM MULT R      INCREASE      R-SQUARE",
0205  &"      SHRUNK R      F-VALUE      DF=1 &      PROB(F)")
0206      WRITE(IUNIT,6030)K,M,RM,UP,RMS,RSH,FRAT,NDF,PP,(XNAME(M,I),
0207  &CI=1,4)
0208 6030  FORMAT(" ",I3,2X,I3,4(4X,F9.6),F11.4,8X,I3,7X,F8.5,5X,4A2)
0209      NINC=NINC+1
0210      OLDR=RM
0211      NX(M)=K
0212      KKM=KKM+1
0213      KXX(KKM)=M
0214      NCK=L-K-1-NEX
0215      IF(NSHR.GT.0)GO TO 6050
0216      WRITE(IUNIT,6040)RSS5,RSS3,EWR
0217 6040  FORMAT(" "/" CORRECTED SHRUNKEN R ESTIMATES: ",2F12.3,
0218  &" ) CUM ERROR PROB: ",F10.6/)

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0219 6050 K=L+1
0220 DO 6060 J=K,NT
0221 M=J-L
0222 6060 WT(M)=R(HC,J)
0223 TEMP=0.
0224 NVBS=L-1-MEX
0225 IF(MFA.GE.0)GO TO 6080
0226 IF(FRAT.GT.FVAL.AND.NINC.LT.NVBS)GO TO 6080
0227 6065 WRITE(IUNIT,6070)
0228 6070 FORMAT("0 FINAL EQUATION: "/)
0229 IFEN=1
0230 6080 CONTINUE
0231 DO 6100 J=1,L
0232 IF(NX(J).LE.0)GO TO 6100
0233 V=SIG(HC)/SIG(J)
0234 IF(TSIG.GT.0.)V=V/RH
0235 X(J)=WT(J)*V
0236 IF(MULT.LE.0)GO TO 6090
0237 XKTP=X(J)*1000./0.5
0238 KTP=XKTP
0239 X(J)=KTP
0240 6090 TEMP=TEMP+X(J)*XBAR(J)
0241 6100 CONTINUE
0242 Z=XBAR(HC)-TEMP
0243 WRITE(IUNIT,6110)
0244 6110 FORMAT(" N VB. MEAN SIGMA Z-WEIGHT",
0245 $" RAW SCR WT CRIT R Z-WT*CRIT R"/)
0246 DO 6130 I=1,L
0247 PROD=SGN(I)*WT(I)
0248 IF(NX(I))6130,6130,6120
0249 6120 WRITE(IUNIT,6150)NX(I),I,XBAR(I),SIG(I),WT(I),X(I),SGN(I),PROD,
0250 $(XNAME(I,J)),J=1,4)
0251 6130 CONTINUE
0252 WRITE(IUNIT,6140)Z
0253 6140 FORMAT(" CONSTANT: ",F10.3)
0254 6150 FORMAT(2X,I3,I4,4X,F10.3,3X,F10.3,7X,F9.5,F13.5,2(3X,F9.5)
0255 $5X,4A2)
0256 WRITE(IUNIT,6160)
0257 6160 FORMAT(" ")
0258 6161 GO TO 6168
0259 65432 IPL=0
0260 WRITE(1,4500)
0261 4500 FORMAT ("ENTER 1 TO PLOT RESIDUALS (Y-PRED VS Y-OBS): ")
0262 READ(1,*) IPL
0263 IF(IPL.EQ.0)GO TO 7000
0264 WRITE(1,4501)
0265 4501 FORMAT(" OUTPUT FILE FOR RESIDUALS IS MAC TAPE!AA")
0266 6162 WRITE(1,4503)
0267 4503 FORMAT ("ENTER RAW DATA FILE NAME: ")
0268 READ(1,3071)IRDFIL
0269 WRITE(1,4504)
0270 4504 FORMAT ("ENTER RAW DATA FORMAT: ")
0271 READ(1,3070)IRFMT
0272 CALL OPEN(IB,IER,IRDFIL,3,0,-2,256)
0273 IF(IER.GE.0)GO TO 6163
0274 WRITE(1,4505) IER
0275 4505 FORMAT ("NO OPEN RAW DATA FILE, IER = ",I5 )
0276 STOP

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0277 6163 WRITE(IUNIT,61635)IRDFIL,IRFMT
0278 WRITE(IUNIT,61636)
0279 61635 FORMAT("INPUT RAW DATA FILE: ",3A2," INPUT DATA FORMAT:",
0280 $20A2)
0281 61636 FORMAT(" RESIDUALS OUTPUT TO TAPE: ",2," (CRITERION,"
0282 $"Y-PREDICTED 2(5X,F10.3) FORMAT)")
0283 DO 6166 I1=1,N
0284 YP=Z
0285 CALL READF(IB,IER,IBUF)
0286 CALL CODE
0287 READ(IBUF,IRFMT)(RDATA(I2),I2=1,L)
0288 DO 6164 I2=1,L
0289 IF(NX(I2).GT.0)YP=YP+X(I2)*RDATA(I2)
0290 6164 CONTINUE
0291 WRITE(8,8185)RDATA(NC),YP
0292 8185 FORMAT(2(5X,F10.3))
0293 6166 CONTINUE
0294 6167 CALL CLOSE(IB)
0295 ENDFILE 8
0296 GO TO 7000
0297 6168 IFIN=0
0298 IF(NCK.LE.0)GO TO 6170
0299 IF(FRAT.GT.FVAL)GO TO 5030
0300 IF(NFA.GE.0)GO TO 5030
0301 6170 IF(NRPT.LE.0)GO TO 62000
0302 NPASS=NPASS+1
0303 IF(KKM.LE.0) GO TO 5647
0304 DO 6190 I=1,KKM
0305 6190 NX(I)=KKX(I)
0306 5647 NINC=0
0307 NTIME=2
0308 KKM=IG3
0309 NFRCE=IG1
0310 NFA=IG2
0311 WRITE(IUNIT,6190)NPASS
0312 6190 FORMAT("1 EQUATION SET: ",I3," ATTEMPTED")
0313 NRPT=NRPT-1
0314 GO TO 4000
0315 62000 CONTINUE
0316 GO TO 65432
0317 7000 WRITE(1,450)
0318 4500 FORMAT("MRH30 FINISHED ***")
0319 CALL CLOSE(IB)
0320 CALL PURGE(IB,IER,INFILE)
0321 RLWIND 8
0322 3071 FORMAT(3A2)
0323 3070 FORMAT(20A2)
0324 STOP 1234
0325 END
0326 END$

```

*MRH31 T=00003 IS ON CR00002 USING 00017 BLKS R=0000

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0001  FTH4
0002      PROGRAM MRH31
0003      COMMON IUNIT,NINC,IFIN,L,N,NC,FVAL,NEX,NFRCE,NTIME,HRPT,
0004      $NPOS,MULT,ICOM,TMM,TSIG,MSMR,AL,NPASS,ICOMM,HFA
0005      COMMON IRDFIL(3),IRFMT(20),RDATA(30)
0006      INTEGER RFMT(20),XNAME
0007      COMMON ISIZE(2),INFILE(3),IFMT(20)
0008      COMMON SGN(30),KFRCE(30),WT(30),KKX(30)
0009      COMMON X(60),HX(30)
0010      COMMON R(30,60),SIG(30),XBAR(30),XNAME(30,4)
0011      COMMON IB(272),IBUF(256)
0012      DIMENSION ISRD(3),NAM1(3)
0013      DATA ISRD/2HSR,2HDA,2HTA/
0014      DATA NAM1 /2HMR,2HM3,2H0 /
0015      WRITE(1,4400)
0016  4400  FORMAT ( "KRHAIN30&" )
0017  1000  DO 1010 I=1,30
0018          SGN(I)=0
0019          KFRCE(I)=0
0020          WT(I)=0
0021          KKX(I)=0
0022          SIG(I)=0
0023          RDATA(I)=0.
0024          XBAR(I)=0
0025          HX(I)=0
0026      DO 1010 J=1,20
0027          RFMT(J)=2H
0028          IFMT(J)=2H
0029      DO 1010 K=1,60
0030          R(I,K)=0
0031          X(K)=0
0032  1010  CONTINUE
0033  900   WRITE(1,4401)
0034  4401  FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: " )
0035      READ(1,*) IUNIT
0036      IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 900
0037      NINC=0
0038      IFIN=0
0039      WRITE(1,4402)
0040  4402  FORMAT ( "&ENTER # VRS IN MATRIX (MAX 30): " )
0041      READ(1,*) L
0042      WRITE(1,4403)
0043  4403  FORMAT ( "&ENTER # SS ON WHICH CORRELS BASED: " )
0044      READ(1,*) N
0045      WRITE(1,4404)
0046  4404  FORMAT ( "&ENTER # OF CRIT VARIABLE: " )
0047      READ(1,*) NC
0048      WRITE(1,4405)
0049  4405  FORMAT("&ENTER MINIMUM ACCEPTABLE F FOR INCLUSION",
0050      C" IN EQUATION. ")

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0051      READ(1,*) FVAL
0052      WRITE(1,4406)
0053 4406  FORMAT ( "ENTER # VBS EXCLUDED, & # VBS FORCED: ")
0054      READ(1,*) NEX,NFRCE
0055      IF(NEX.GT.0) WRITE(1,543)
0056 543   FORMAT(" ENTER #'S OF VBS. TO EXCLUDE (ANY ORDER): ")
0057      IF(NEX.GT.0) READ(1,*) (NX(I),I=1,NEX)
0058      IF(NFRCE.GT.0) WRITE(1,544)
0059 544   FORMAT("ENTER #'S OF VBS. TO FORCE (IN DESIRED ORDER)!")
0060      IF(NFRCE.GT.0) READ(1,*) (KFRCE(I),I=1,NFRCE)
0061      WRITE(1,4407)
0062 4407  FORMAT ( "ENTER # OF THIS EQUATION: ")
0063      READ(1,*) NTIME
0064      WRITE(1,4408)
0065 4408  FORMAT ( "ENTER # OF ADDITIONAL COMPOSITES DESIRED: ")
0066      READ(1,*) NRPT
0067      NPOS=0
0068      MULT=0
0069      ICON=0
0070      THN=0
0071      TSIG=0
0072      NSHR=0
0073      WRITE(1,4410)
0074 4410  FORMAT ( "IN THE FOLLOWING DIALOG, 1 = YES, 0 = NO." )
0075      WRITE(1,4411)
0076 4411  FORMAT ( "SUPPRESS WT REVERSALS? ")
0077      READ(1,*) NPOS
0078      WRITE(1,4412)
0079 4412  FORMAT ( "MULT WTS BY 1000? ")
0080      READ(1,*) MULT
0081      WRITE(1,4413)
0082 4413  FORMAT ( "SET MEAN OF PREDICTED SCORES? ")
0083      READ(1,*) ICON
0084      IF(ICON.EQ.1) WRITE(1,531)
0085 531   FORMAT("ENTER MEAN: ")
0086      IF(ICON.EQ.1) READ(1,*) THN
0087      WRITE(1,4414)
0088 4414  FORMAT ( "SET SD OF PREDICTED SCORES? ")
0089      READ(1,*) ICON
0090      IF(ICON.EQ.1) WRITE(1,545)
0091 545   FORMAT("ENTER SD: ")
0092      IF(ICON.EQ.1) READ(1,*) TSIG
0093      WRITE(1,4415)
0094 4415  FORMAT ( "SUPPRESS ADDITIONAL SHRUNKEN R ESTIMATES? ")
0095      READ(1,*) NSHR
0096      AL=L-1-NEX
0097      NPASS=1
0098      WRITE(1,4418)
0099 4418  FORMAT ( "CHECK ABOVE PARAMETERS, ENTER 1 TO CONTINUE, 0 TO",
0100      $"RESTART: ")
0101      READ(1,*) ICONM
0102      IF(ICONM.EQ.0)GO TO 1000
0103 20000 IF(IUNIT.NE.6)GO TO 2080
0104      WRITE(IUNIT,2010)

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0105 2010 FORMAT("1  OUTPUT FROM MULTR2"/" *** SELECTED OPTIONS ***")
0106      WRITE(IUNIT,2020)L,N,FVAL
0107 2020 FORMAT("  # VBS = ",I3/"  # SS = ",I3/"  F-VALUE = ",F7.0)
0108 C ... PRINT OPTIONS SELECTED
0109      IF(NFRCE.GT.0)WRITE(IUNIT,2030)(KFRCE(I),I=1,NFRCE)
0110 2030 FORMAT("  FORCING SEQUENCE: ",10I3)
0111      IF(NPOS.GT.0)WRITE(IUNIT,2040)
0112 2040 FORMAT("  MT. REVERSALS SUPPRESSED.")
0113      IF(NEX.GT.0)WRITE(IUNIT,2050)(NX(I),I=1,NEX)
0114 2050 FORMAT("//"  VBS. EXCLUDED: ",10I3)
0115      IF(TMH.GT.0)WRITE(IUNIT,2060)TMH
0116 2060 FORMAT("  ESTABLISH MEAN OF PREDICTED SCORES AT: ",F10.3)
0117      IF(TSIG.GT.0)WRITE(IUNIT,2070)TSIG
0118 2070 FORMAT("  ESTABLISH STANDARD DEVIATION OF PREDICTED SCORES AT: "
0119      $,F10.3,"  [SD OF CRIT. WILL EQU: (SD OF PRED SCORE)/R1")
0120 2080 NTA=NFRCE
0121      CALL EXEC(9,NAM1)
0122      END
0123      END$

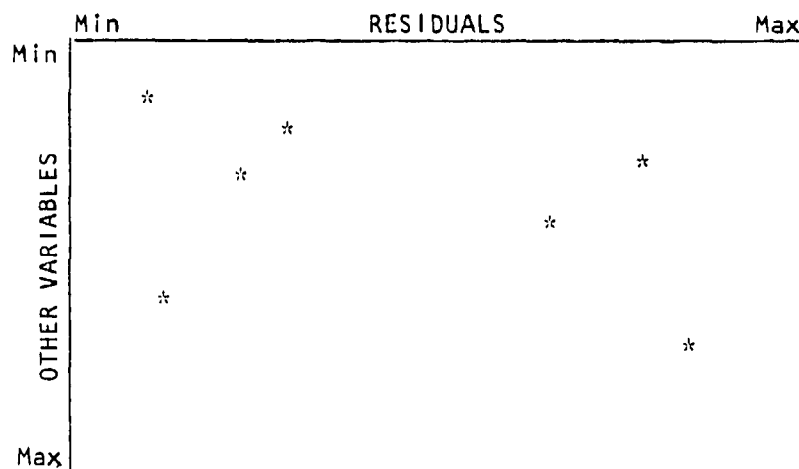
```

RESID (Residual Plot)

Purpose:

This program is used to calculate residuals from data obtained from the MRMAIN program and to plot the residuals against Y-HAT or another independent variable.

Graphic Display:



User Considerations and Procedures:

1. Program reads off magnetic tape, Y-criterion and Y-predicted values created by MRMAIN (see MRMAIN). RESID then calculates the residuals by the formula:

$$\text{Residuals} = (\text{Y-predicted}) - (\text{Y-criterion}).$$

2. Option: enter 0 to plot Y-HAT (Y-predicted) vs residuals; enter variable number of raw data file to plot that independent variable vs residuals; enter -999 to end program.
3. Enter number of observations (program plots out residual for each observation).
4. Enter number of variables on raw data file.
5. Enter name of raw data file.
6. Enter format and record length of raw data file.
7. Enter 1 for CRT display or 6 for line printer display of data.

Comments:

If the device chosen for display was the CRT, the program transfers the CRT graph to hardcopy before doing another plot. If a hardcopy is not desired, turn hardcopy unit off.

On line printer output, a cleaner representation can be obtained by turning the paper over so there are no lines on the printed page.

RU,RESID
PROGRAM TO ANALYSE RESIDUALS BY PLOTTING YHAT VS
RESIDUALS AND/OR ANY INDEPENDENT VARIABLE VS RESIDUALS

ENTER 0 TO PLOT YHAT
VAR # TO PLOT THAT VARIABLE
-999 TO STOP

0
ENTER NUMBER OF OBSERVATIONS
32
ENTER NUMBER OF VARIABLES
8
ENTER NAME OF DATA FILE NAME
#FATAA
ENTER FORMAT OF RAW DATA
(8(2X,F6.2))
ENTER THE RECORD LENGTH AS IN DA30
64
ENTER 1 FOR CRT, OR 6 FOR LINEPRINTER GRAPH
6

ENTER 0 TO PLOT YHAT
VAR # TO PLOT THAT VARIABLE
-999 TO STOP
2

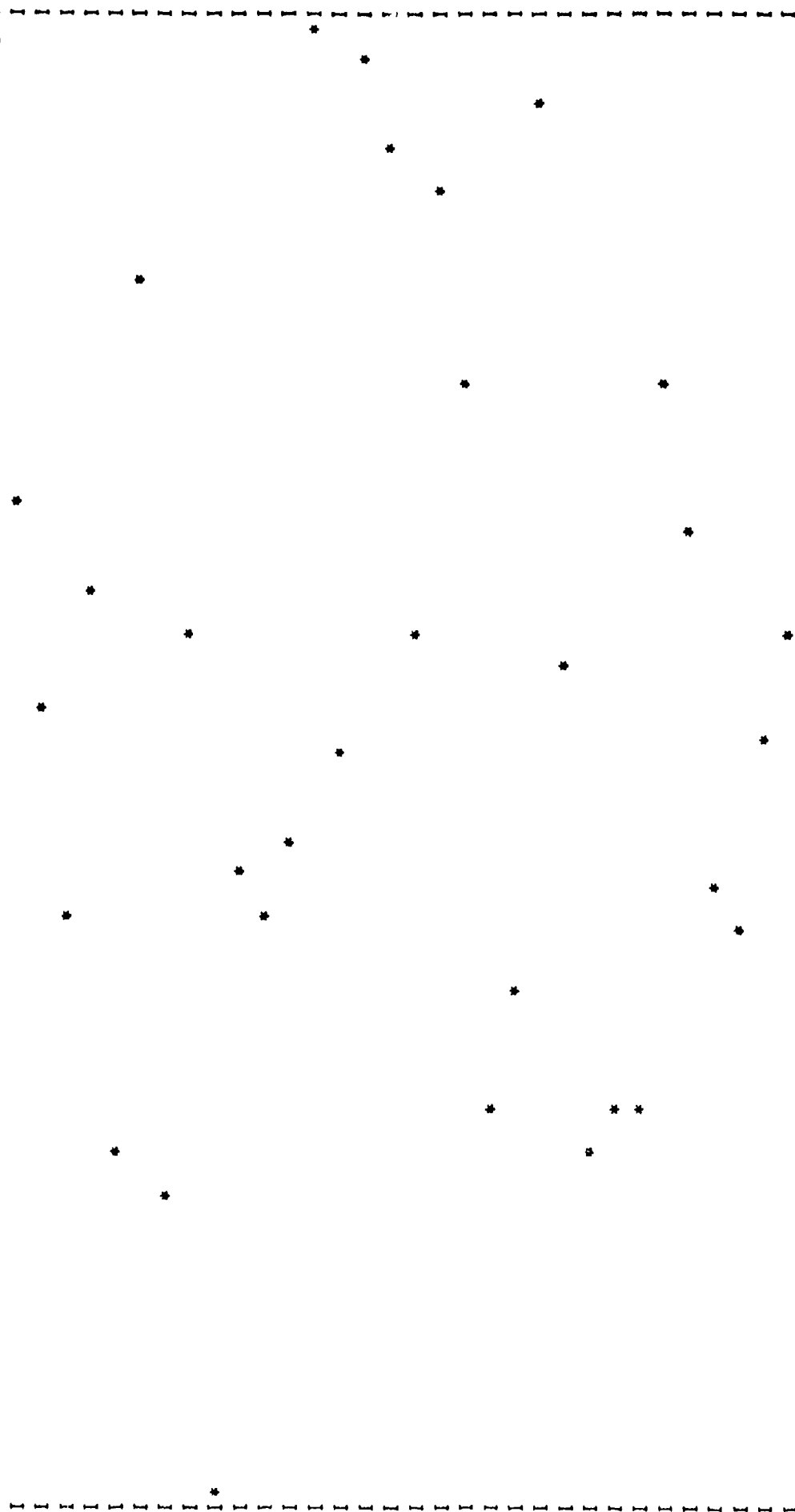
ENTER 0 TO PLOT YHAT
VAR # TO PLOT THAT VARIABLE
-999 TO STOP
-999

:

OPTION TAKEN 0

YMIN = -37.6070023 YMAX = 31.9739990

YMIN 0 YMAX



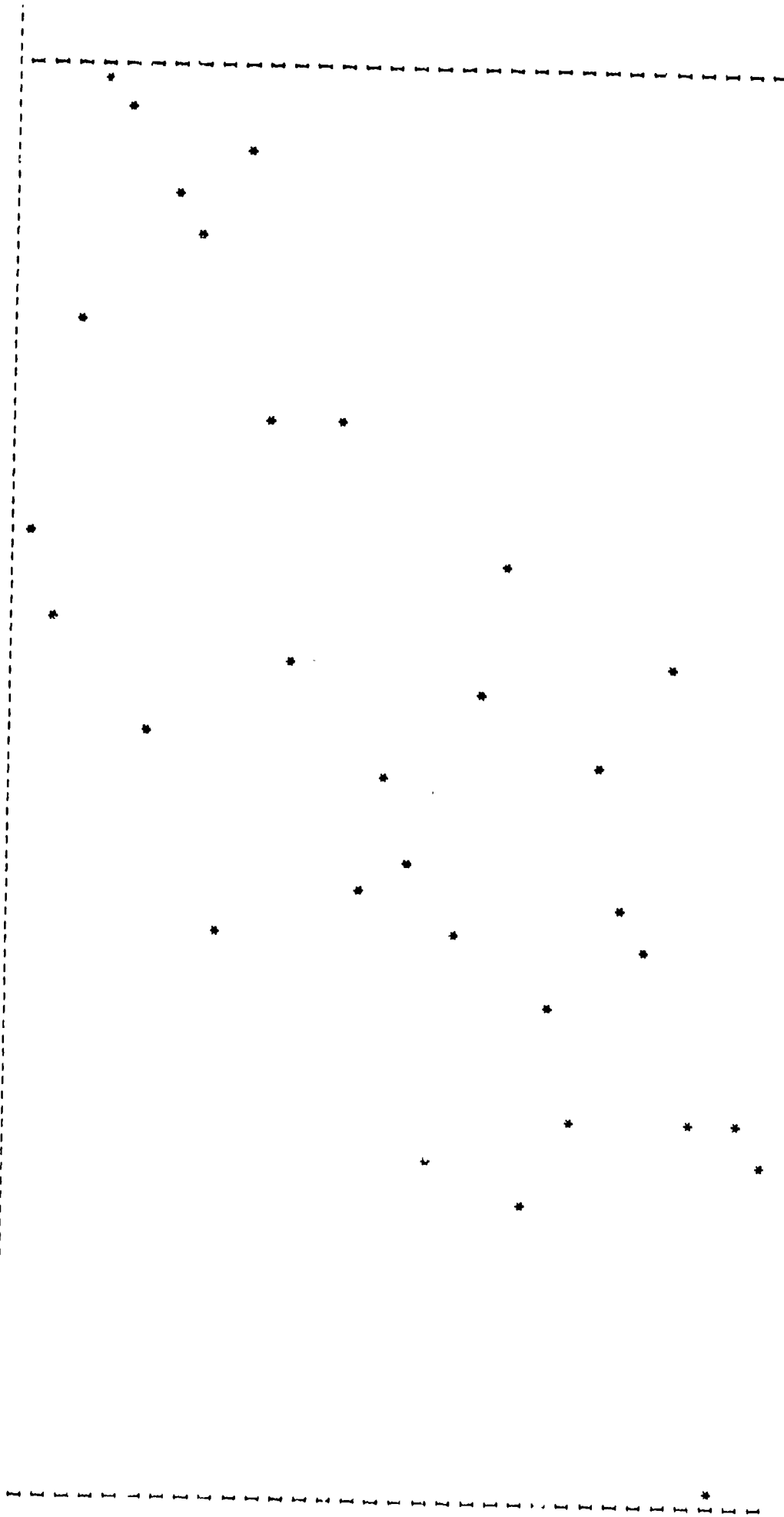
OPTION TAKEN 2

YMIN = -37.6070023 YMAX = 31.9739990

YMIN

YMAX

0



*RESID T=00003 IS ON CR00002 USING 00022 BLKS R=0000

```

0001  FTM4,L,A
0002      PROGRAM RESID
0003      COMMON IUNIT,HSUB,X(2,1000),Y(30),IBUF(256),IB(272)
0004      COMMON IFMT(20),NAME(3),IC(120),ID(75)
0005      DO 10 I=1,120
0006  10      IC(I)=2H
0007      DO 234 I=1,75
0008  234      ID(I)=2H
0009          IC(1)=1H
0010          IC(2)=1HY
0011          IC(3)=1HM
0012          IC(4)=1HI
0013          IC(5)=1HN
0014          IC(102)=1HY
0015          IC(103)=1HM
0016          IC(104)=1HA
0017          IC(105)=1HX
0018      DO 103 I=1,5
0019  103      ID(I)=IC(I)
0020      DO 104 I=1,4
0021  104      ID(I+63)=IC(I+101)
0022          I78=154148
0023          I77=154278
0024          WRITE(1,1)
0025  1      FORMAT(" PROGRAM TO ANALYSE RESIDUALS BY PLOTTING YHAT VS",
0026          $/, " RESIDUALS AND/OR ANY INDEPENDENT VARIABLE VS RESIDUALS")
0027          NTIME=0
0028  2      WRITE(1,3)
0029  3      FORMAT(// "ENTER 0 TO PLOT YHAT ",/,5X,"VAR # TO PLOT THAT ",
0030          $"VARIABLE ",/, " -999 TO STOP")
0031          READ(1,*) ICOM
0032          IF(ICOM.LT.0) GO TO 999
0033          IF(NTIME.NE.0) GO TO 100
0034          WRITE(1,4)
0035  4      FORMAT("ENTER NUMBER OF OBSERVATIONS")
0036          READ(1,*) HSUB
0037          NTIME=NTIME+1
0038          WRITE(1,5)
0039  5      FORMAT("ENTER NUMBER OF VARIABLES")
0040          READ(1,*) HVAR
0041          WRITE(1,6)
0042  6      FORMAT("ENTER NAME OF DATA FILE NAME")
0043          READ(1,7) NAME
0044  7      FORMAT(3A2)
0045          WRITE(1,8)
0046  8      FORMAT("ENTER FORMAT OF RAW DATA")
0047          READ(1,9) IFMT
0048  9      FORMAT(20A2)
0049          IDCBS=256
0050          CALL OPEN(IB,IERR,NAME,3,0,-2,IDCBS)
0051          IF(IERR.GE.0) GO TO 77
0052          WRITE(1,78) NAME,IERR
0053  78      FORMAT(5X,3A2," FAILED TO OPEN ",15," ERROR #")
0054          STOP

```



```

0055 77 WRITE(1,4403)
0056 4403 FORMAT("ENTER 1 FOR CRT , OR 6 FOR LINEPRINTER GRAPH")
0057 READ(1,*) IUNIT
0058 IF(IUNIT.NE.1) GO TO 100
0059 WRITE(1,83) I77,I78
0060 83 FORMAT("TURN OF HARD COPY UNIT POWER, IF HARD COPY",/,5X,
0061 $"IS NOT DESIRED",2A2)
0062 100 CONTINUE
0063 CALL RWPDF(IB)
0064 REWIND 8
0065 DO 15 I = 1,NSUB
0066 READ(8,11) CRIT,YHAT
0067 11 FORMAT(2(5X,F10.3))
0068 RES=YHAT-CRIT
0069 IF(ICOM.EQ.0) GO TO 20
0070 CALL READF(IB,IER,IBUF)
0071 CALL CODE
0072 READ(IBUF,IFMT) (Y(J),J=1,NVAR)
0073 X(1,I)=Y(ICOM)
0074 GO TO 21
0075 20 X(1,I)=YHAT
0076 21 X(2,I)=RES
0077 15 CONTINUE
0078 CALL SORT(YMIN,YMAX)
0079 IF(IUNIT.EQ.1) GO TO 59
0080 WRITE(6,55) ICOM
0081 55 FORMAT("1 OPTION TAKEN",I7,/)
0082 GO TO 63
0083 59 WRITE(1,84) I78
0084 84 FORMAT(A2)
0085 WRITE(1,55) ICOM
0086 63 WRITE(IUNIT,56) YMIN,YMAX
0087 56 FORMAT(" YMIN = ",F14.7,5X,"YMAX = ",F14.7,/)
0088 IF(YMIN.LT.0.AND.YMAX.GT.0) GO TO 57
0089 IF(IUNIT.EQ.1) GO TO 65
0090 WRITE(6,16)
0091 16 FORMAT(3X,"YMIN",97X,"YMAX")
0092 GO TO 66
0093 65 WRITE(1,17)
0094 17 FORMAT("YMIN",58X,"YMAX")
0095 GO TO 66
0096 57 RANGE=YMAX-YMIN
0097 Z=-YMIN/RANGE
0098 IF(IUNIT.EQ.1) GO TO 67
0099 IV=99.*Z+.5
0100 IF(IV.GT.5.AND.IV.LT.98) GO TO 70
0101 WRITE(6,16)
0102 GO TO 66
0103 70 IC(IV+3)=1H0
0104 WRITE(6,71) (IC(I),I=1,105)
0105 71 FORMAT(105A1)
0106 IC(IV+3)=1H
0107 GO TO 66
0108 67 IV=59.*Z+.5
0109 IF(IV.GT.5.AND.IV.LT.58) GO TO 72
0110 WRITE(1,17)
0111 GO TO 66

```

```

0112 72 ID(IV+3)=1H0
0113 WRITE(1,73) (ID(I),I=1,67)
0114 73 FORMAT(67A1)
0115 ID(IV+3)=1H
0116 66 CONTINUE
0117 IF(IUNIT.EQ.1) WRITE(1,564)
0118 564 FORMAT(70(" "),/)
0119 IF(IUNIT.EQ.6) WRITE(6,566)
0120 566 FORMAT(110(" "))
0121 CALL STD(YMIN,YMAX)
0122 CALL PLOT
0123 IF(IUNIT.EQ.1) WRITE(1,569) I77,I78
0124 569 FORMAT(2A2)
0125 GO TO 2
0126 999 WRITE(1,30)
0127 30 FORMAT(///,"RESIDUAL ANALYSIS COMPLETE")
0128 CALL CLOSE(18)
0129 REWIND 8
0130 END
0131 SUBROUTINE STD(XMIN,XMAX)
0132 COMMON IUNIT,NSUB,X(2,1000)
0133 RANGE=XMAX-XMIN
0134 DO 10 I=1,NSUB
0135 10 X(2,I)=(X(2,I)-XMIN)/RANGE
0136 RETURN
0137 END
0138 SUBROUTINE PLOT
0139 COMMON IUNIT,NSUB,X(2,1000)
0140 DIMENSION IA(100)
0141 DATA ISTAR/1H*//,IBLANK/1H /
0142 DO 10 I=1,NSUB
0143 DO 20 L=1,100
0144 20 IA(L)=IBLANK
0145 ZK=59.
0146 IF(IUNIT.EQ.6) ZK=99.
0147 Z=X(2,I)
0148 J=ZK*Z + 1
0149 IA(J)=ISTAR
0150 IF(IUNIT.EQ.1) GO TO 30
0151 WRITE(IUNIT,1) IA
0152 1 FORMAT(4X,"I",100A1,"I")
0153 GO TO 10
0154 30 WRITE(1,2) (IA(M),M=1,60)
0155 2 FORMAT(3X,"I",60A1,"I")
0156 10 CONTINUE
0157 RETURN
0158 END
0159 SUBROUTINE SORT(YMIN,YMAX)
0160 COMMON IUNIT,NSUB,X(2,1000)
0161 YMIN=X(2,1)
0162 YMAX=YMIN
0163 DO 10 I=1,NSUB
0164 YMIN=AMIN1(YMIN,X(2,I))
0165 YMAX=AMAX1(YMAX,X(2,I))
0166 10 CONTINUE
0167 N1=NSUB-1
0168 DO 1 I=1,N1

```

```

0169      J=1+I
0170      DO 2 K=J, NSUB
0171      IF(X(1,I).LE.X(1,K)) GO TO 2
0172      TEMP=X(1,I)
0173      X(1,I)=X(1,K)
0174      X(1,K)=TEMP
0175      TEMP=X(2,I)
0176      X(2,I)=X(2,K)
0177      X(2,K)=TEMP
0178 2      CONTINUE
0179      1 CONTINUE
0180      RETURN
0181      END
0182      END$

```

FATAA (Factor Analysis)

Purpose:

FATAA computes principal components of a correlation matrix and, optionally, follows with a principal factor analysis using squared multiple correlations as communality estimates. If desired, the principal factor analysis may be iterated until communalities stabilize within an specified tolerance.

Principal components analysis may be run alone or used as a beginning point for the factor analysis. In the factor analysis, the number of factors extracted will be equal to the number of eigenvalues from the principal components analysis which are greater than one, unless a smaller number is specified.

As with any analysis involving matrix inversion, care should be taken not to include variables which are completely predictable from linear combination of other variables included. In practice, variables with very high multiple correlation (.98 or above) are likely to involve inversion problems. The program will detect such linear dependencies, exclude those variables from the analysis, and repeat the analysis with the reduced matrix.

User Considerations and Procedures:

1. Program SRM30 must be run first to give FATAA initial correlation matrix, variable means, standard deviation, and variable names.
2. Program has option for calling varimax rotation program. If this option is used, before running FATAA, enter RP, VARI. After FATAA and VARI is complete enter 'OF, VARI'.
3. Program uses disc files 'SCRTCH' and 'REDMTX'. These should never be purged from disc. Also, program creates user files for other programs such as for varimax rotation. These should be treated as regular data files and should be purged (deleted) from the disc when not needed.
4. Initial options and parameters:
 - a. option for device output, enter 1 for CRT output or 6 for line printer
 - b. enter number of variables from SRM30 (maximum 30)
 - c. enter 1 for principal component solution only, enter 0 for principal component and principal factor solutions

- d. enter maximum number of factors to be extracted (maximum of 30). This should not be greater than number of variables. A zero value defaults to 30
 - e. enter maximum number of iterations for principal factor solutions. A zero value defaults to 1. NOTE: The more iterations requested, the longer the program takes
 - f. maximum number of iterations for eigenvalue extraction. A zero value defaults to 10
 - g. enter convergence criterion for eigenvalue extraction. A zero value defaults to .01
 - h. enter convergence criterion for stabilization of communalities. Iteration will stop when all communalities change less than this value across iterations. A zero value defaults to .01, which is considered stringent. For a moderately unstable solution, .03 or .05 is better
 - i. enter number of variables to be excluded from the analysis
 - j. enter 1 for a printout of intermediate results, otherwise enter 0. This option slows down the program and should only be used when convergence is uncertain
 - k. enter lowest acceptable eigenvalue (for consideration as a factor). A zero value defaults to 1.00
 - l. enter the numbers of variables to exclude in any order, separated by commas. (If response to option i was 0, this option does not occur)
 - m. name of output file for principal component solution
 - n. name of output file for principal factor solution, if optioned for
 - o. enter 1 to call varimax rotation program (VARI); else enter 0. (See (2) User Considerations and Procedures.) NOTE: After FATAA is finished, you can call VARI by hand, by entering RU, VARI. All options for varimax rotation program is given in VARI.
5. Printout gives:
- a. rank of matrix, determinant, and a list of variables eliminated during inversion due to linear dependencies
 - b. final r matrix, after exclusions and eliminations
 - c. principal components solution

- 1) number of factors with eigenvalues greater than 1.0
 - 2) total percent of variance explained by the number of factors extracted
 - 3) estimated common variance
 - 4) for each factor, eigenvalue and percent of variance explained
 - 5) commonality for each variable
 - 6) factor loading matrix
- d. correlation matrix with squared multiple correlations in diagonal
- e. principal factor solution
- 1) if iterated, commonality for each iteration and its change from preceding iteration, and factor matrix if elected by option
 - 2) when iterations are completed, output for the principal factor solution corresponding to c-1 through c-6 above

Test Data:

This program was tested using the same data as SRM30 (See SRM30). The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to four or five digit places instead of ten digits.

RP,VARI
 :RU,FATAA
 PRINCIPAL COMPONENTS/FACTOR ANALYSIS
 NOTE: THIS PROGRAM WILL OPEN/READ/WRITE SEVERAL DISC FILES
 'SCRATCH'; 'REDMTX'; 2 USER FILES
 IT WOULD BE PRUDENT TO CHECK FOR EXISTING FILES
 BEFORE RUNNING
 ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:
 6
 ENTER # OF VBS. IN MATRIX:
 8
 ENTER 1 FOR PRINCIPAL COMPONENTS ONLY, 0 FOR PRINCIPAL
 COMPONENTS AND PRINCIPAL FACTORS:
 0
 ENTER MAX # OF FACTORS TO BE EXTRACTED (0 DEFAULTS TO 30):
 8
 ENTER MAX # OF ITERATIONS OF PRINCIPAL FACTOR SOLUTIONS
 (0 DEFAULTS TO 1):
 25
 ENTER MAX # ITERATIONS FOR EIGEN VALUE EXTRACTION
 (0 DEFAULTS TO 10):
 50
 ENTER CONVERGENCE CRITERION FOR EIGEN VALUE EXTRACTION
 (0 DEFAULTS TO .01):
 .005
 ENTER CRITERION FOR STABILIZING COMMUNALITIES
 (0 DEFAULTS TO .01):
 .005
 ENTER # OF VARIABLES TO BE EXCLUDED BEFORE ANALYSIS:
 0
 ENTER 1 TO PRINT INTERMEDIATE ITERATIONS, 0 OTHERWISE:
 0
 ENTER LOWEST ACCEPTABLE EIGEN VALUE
 (0 DEFAULTS TO 1.00):
 1
 COMPUTE PRINCIPAL COMPONENTS
 COMPUTE COMMUNALITY
 PRINCIPAL COMPONENTS SOLUTION OUTPUT NOW
 PRINT FACTOR MATRIX
 ENTER NAME OF THIS OUTPUT FILE:
 OUTP1
 COMPUTE INVERSE
 PRINT FACTOR MATRIX
 ENTER NAME OF THIS OUTPUT FILE:
 OUTP2
 ENTER 1 TO CALL VARIMAX
 1
 VARIMAX
 ENTER 1 FOR CRT OUTPUT, 6 TO LPT:
 6
 ENTER # OF SETS OF ROTATION (MAX IS 25):
 1

ROTATE WITH & W/OUT GENERAL FACTOR (I=Y, Ø=N):

Ø

ENTER #'S OF FACTORS IN EACH SET TO BE ROTATED FROM SMALLEST TO LARGEST:

3

WOULD YOU PREFER TO SKIP THE PRINCIPAL COMPONENT
SOLUTION AND PERFORM ONLY THE PRINCIPAL AXIS SOLUTION?

(I=Y, Ø=N):

Ø

MS1, NV = 8

ENTER NAME OF FILE CONTAINING FACTOR MATRIX FOR PRINCIPAL COMPONENTS:

OUTP1

MS2, NFR = 3

BIG LOOP THRU NX SETS OF SEPARATE ROTATION PROBLEMS

OBTAIN RESIDUAL CORRELATIONS

ENTER NAME OF FILE CONTAINING FACTOR MATRIX FOR PRINCIPAL AXIS SOLUTION:

OUTP2

MS2, NFR = 3

BIG LOOP THRU NS SETS OF SEPARATE ROTATION PROBLEMS

OBTAIN RESIDUAL CORRELATIONS

ENTER 1 TO CONTINUE, Ø TO END RUN:

Ø

VARI : STOP 0000

Ø

FATAA : STOP 0000

:OF,VARI

VARI ABORTED

:

NUMBER OF VARIABLES. 8
 RANK OF MATRIX 8
 DETERMINANT 1946902E-03

CORRELATION MATRIX

	1	2	3	4	5	6	7	8
A	1	1.0000						
B	2	.2301	1.0000					
C	3	-.2057	.3379					
D	4	-.2388	-.2689	1.0000				
E	5	-.2014	-.2920	.9689	1.0000			
F	6	-.2070	-.1948	.9375	.8408	1.0000		
G	7	-.3045	-.1690	.6105	.6300	.4869	1.0000	
H	8	-.3451	-.3307	.3755	.4281	.2326	.6872	1.0000

PRINCIPAL COMPONENTS SOLUTION

FACTOR EXTRACTION STATISTICS

NUMBER OF FACTORS 3
 PERCENT OF VARIANCE 8230
 ESTIMATED COMMON VARIANCE 1.0000

FACTOR	EIGENVALUE	PERCENT VARIANCE	CUMULATIVE PERCENT
1	4.0257	.5032	.5032
2	1.4783	.1848	.6880
3	1.0802	.1350	.8230

COMMUNALITIES

VARIABLE	COMMUNALITY
A	.5316
B	.8506
C	.8531
D	.9852
E	.9308
F	.8982
G	.7763
H	.7583

FACTOR MATRIX

	1	2	3
A	.4035	.3209	-.5155
B	.3052	.7904	.3644
C	-.5507	.6546	.3484
D	-.9429	.1252	-.2836
E	-.9240	.0611	-.2708
F	-.8559	.2173	-.3442
G	-.8013	-.0678	.3600
H	-.5908	-.5009	.3980

CORRELATION MATRIX

	1	2	3	4	5	6	7	8
A	.2396							
B	.2301	.4440						
C	-.2057	.3379	.6198					
D	-.2388	-.2689	.4819	.9922				
E	-.2014	-.2920	.4241	.9689	.9798			
F	-.2070	-.1948	.4659	.9375	.8408	.9604		
G	-.3045	-.1630	.4920	.6105	.6300	.4869	.7055	
H	-.3451	-.3307	.0846	.3755	.4281	.2326	.6872	.6021

NOTE: DIAGONAL ENTRIES ARE SQUARED MULTIPLE CORRELATIONS OF EACH VARIABLE WITH THE OTHER N-1 VARIABLES.

FACTOR EXTRACTION STATISTICS

NUMBER OF FACTORS	3
PERCENT OF VARIANCE	.7276
ESTIMATED COMMON VARIANCE	.7276

FACTOR	EIGENVALUE	PERCENT VARIANCE	CUMULATIVE PERCENT
1	3.8808	.4851	.4851
2	1.1342	.1418	.6269
3	.8059	.1007	.7276

COMMUNALITIES

VARIABLE	COMMUNALITY
A	.1605
B	.5957
C	.7442
D	1.0626
E	.8862
F	.8556
G	.8211
H	.6950

FACTOR MATRIX

	1	2	3
A	.3185	-.1727	-.1709
B	.2777	-.6648	.2768
C	-.5322	-.5910	.3343
D	-.9874	-.0869	-.2831
E	-.9205	-.0123	-.1969
F	-.8590	-.2269	-.3164
G	-.7728	.1255	.4562
H	-.5437	.4881	.4014

VARIABLES UNDER ANALYSIS

A	B	C	D	E	F	G	H
OUTP1							
1 1	.4034796	.3051817	-.5507126	-.9429269	-.9239882	-.8559079	-.8012877
1 2	-.5907568						
2 1	.3209112	.7903879	.6545957	.1251977	.0610765	.2172822	-.0678236
2 2	-.5009069						
3 1	-.5155404	.3644105	.3483532	-.2836099	-.2708402	-.3441698	.3600312
3 2	.3980054						

ITER. 1	3ROTATIONS OUT OF	3 MORE THAN	.01 DEGREES
ITER. 2	3ROTATIONS OUT OF	3 MORE THAN	.01 DEGREES
ITER. 3	2ROTATIONS OUT OF	3 MORE THAN	.01 DEGREES
ITER. 4	0ROTATIONS OUT OF	3 MORE THAN	.01 DEGREES

PRINCIPAL COMPONENTS SOLUTION

KAISER VARIMAX ROTATED FACTOR MATRIX
8 VARIABLES X 3 FACTORS

VAR IDEN #	1	2	3
A	.035	-.007	-.728
B	.247	.851	-.255
C	-.463	.764	.234
D	-.968	.004	.220
E	-.931	-.045	.249
F	-.942	.048	.089
G	-.506	.162	.703
H	-.208	-.200	.822

SUM OF FACTOR LDGS SQD 3.268 1.379 1.937
 PERCENT OF VARIANCE 40.852 17.236 24.214

TOTAL PERCENT OF VARIANCE OF 3 FACTORS = 82.303

RESIDUAL CORRELATION MATRIX - 3 FACTORS EXTRACTED
 UPR RH=ORIGINAL CORRELATIONS
 DIAGONAL=COMMUNALITY
 LWR LH=RESIDUAL CORRELATIONS

VAR IDEN #	1	2	3	4	5	6	7	8
A	.532	.230	-.206	-.239	-.201	-.207	-.304	-.345
B	.041	.851	.338	-.269	-.292	-.195	-.169	-.331
C	-.015	-.138	.853	.482	.424	.466	.492	.085
D	-.045	.023	-.021	.985	.969	.938	.610	.376
E	.012	.040	-.030	.013	.931	.841	.630	.428
F	-.109	.020	-.028	.006	-.057	.898	.487	.233
G	.226	-.002	-.030	-.034	-.009	-.060	.776	.687
H	.259	.100	-.051	-.006	.021	-.027	.037	.758

OUTP2

1	1	.3185080	.2777376	-.5321764	-.9873664	-.9204900	-.8390125	-.7728373
1	2	-.5437081						
2	1	-.1727054	-.6647741	-.5909611	-.0869128	-.0122773	-.2269451	.1254906
2	2	.4881231						
3	1	-.1709202	.2767981	.3342820	-.2830939	-.1969187	-.3164412	.4561766
3	2	.4014435						

ITER.	1	3 ROTATIONS OUT OF	3 MORE THAN	.01 DEGREES
ITER.	2	3 ROTATIONS OUT OF	3 MORE THAN	.01 DEGREES
ITER.	3	2 ROTATIONS OUT OF	3 MORE THAN	.01 DEGREES
ITER.	4	0 ROTATIONS OUT OF	3 MORE THAN	.01 DEGREES

PRINCIPAL AXIS SOLUTION:

KAISER VARIMAX ROTATED FACTOR MATRIX

8 VARIABLES X 3 FACTORS

VAR IDENT #	1	2	3
A	.133	-.034	-.376
B	.204	-.690	-.280
C	-.417	-.713	.248
D	-.980	.008	.319
E	-.863	.031	.376
F	-.909	-.082	.147
G	-.376	-.188	.803
H	-.124	.164	.808

SUM OF FACTOR LDGS SQD	2.922	1.055	1.844
PERCENT OF VARIANCE	36.523	13.192	23.046
TOTAL PERCENT OF VARIANCE OF	3 FACTORS	=	72.762

RESIDUAL CORRELATION MATRIX - 3 FACTORS EXTRACTED
 UPB RH-ORIGINAL CORRELATIONS
 DIAGONAL=COMMUNALITY
 LWR LH=RESIDUAL CORRELATIONS

VAR	IDEN #	1	2	3	4	5	6	7	8
A	1	.160	.230	-.206	-.239	-.201	-.207	-.304	-.345
B	2	.074	.596	.338	-.269	-.292	-.195	-.169	-.331
C	3	-.081	.000	.744	.482	.424	.466	.492	.085
D	4	.012	.026	-.000	1.063	.969	.938	.610	.376
E	5	.056	.010	-.007	.003	.886	.841	.630	.428
F	6	-.033	-.025	-.009	-.000	.003	.656	.487	.233
G	7	.041	.003	.002	-.013	.010	.011	.821	.687
H	8	-.019	.034	-.050	-.005	.013	.014	.023	.695

*FATAA T=00004 IS ON CR00002 USING 00062 BLKS R=0492

```

0001  FTH4
0002      PROGRAM FATAA
0003      INTEGER XID
0004      DIMENSION X(30),COM(30),Y(30),INFILE(3),IFMT(20),IOFILE(3)
0005      DIMENSION ISIZE(2)
0006      COMMON NELVA(30),XID(30,4),NEX
0007      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0008      DIMENSION IB(272),IBUF(256),IDA(3),IRDX(3),ISCR(3),NVARI(3)
0009      DATA NVARI/2HVA,2HRI,2H /
0010      DATA ISCR/2HSC,2HRT,2HCH/
0011      DATA IRDX/2HRE,2HDM,2HTX/
0012      DATA IDA/2HSR,2HDA,2HTA/
0013      WRITE(1,4400)
0014  4400  FORMAT ( "PRINCIPAL COMPONENTS/FACTOR ANALYSIS" )
0015      WRITE(1,4401)
0016  4401  FORMAT("NOTE: THIS PROGRAM WILL OPEN/READ/WRITE SEVERAL DISK ",
0017      $"FILES")
0018      WRITE(1,4402)
0019  4402  FORMAT ( " 'SCRATCH'; 'REDMTX'; 2 USER FILES" )
0020      WRITE(1,4403)
0021  4403  FORMAT ( "IT WOULD BE PRUDENT TO CHECK FOR EXISTING FILES" )
0022      WRITE(1,4404)
0023  4404  FORMAT ( "BEFORE RUNNING" )
0024      WRITE(1,4405)
0025  4405  FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT: " )
0026      READ(1,*) IUNIT
0027  1500  WRITE(1,4406)
0028  4406  FORMAT ( "ENTER # OF VBS. IN MATRIX: " )
0029      READ(1,*) NV
0030      WRITE(1,4407)
0031  4407  FORMAT("ENTER 1 FOR PRINCIPAL COMPONENTS ONLY, 0 FOR PRINCIPAL")
0032      WRITE(1,4408)
0033  4408  FORMAT ( "COMPONENTS AND PRINCIPAL FACTORS: " )
0034      READ(1,*) NTP
0035      WRITE(1,4409)
0036  4409  FORMAT( "ENTER MAX # OF FACTORS TO BE EXTRACTED (0 DEFAULTS ",
0037      X"TO 30): " )
0038      READ(1,*) MAXFAC
0039      WRITE(1,4410)
0040  4410  FORMAT("ENTER MAX # OF ITERATIONS OF PRINCIPAL FACTOR ",
0041      C"SOLUTIONS")
0042      WRITE(1,4411)
0043  4411  FORMAT ( "(0 DEFAULTS TO 1): " )
0044      READ(1,*) MAXIT
0045      WRITE(1,4412)
0046  4412  FORMAT ( "ENTER MAX # ITERATIONS FOR EIGENVALUE EXTRACTION " )
0047      WRITE(1,4413)
0048  4413  FORMAT ( "(0 DEFAULTS TO 10): " )
0049      READ(1,*) ITHAX
0050      WRITE(1,4414)

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0051 4414 FORMAT("ENTER CONVERGENCE CRITERION FOR EIGENVALUE EXTRACTION")
0052 WRITE(1,4415)
0053 4415 FORMAT ( "(0 DEFAULTS TO .01): ")
0054 READ(1,*) EPS
0055 WRITE(1,4416)
0056 4416 FORMAT ( "ENTER CRITERION FOR STABILIZING COMMUNALITIES " )
0057 WRITE(1,4417)
0058 4417 FORMAT ( "(0 DEFAULTS TO .01): ")
0059 READ(1,*) CRIT
0060 WRITE(1,4418)
0061 4418 FORMAT("ENTER # OF VARIABLES TO BE EXCLUDED BEFORE ANALYSIS: ")
0062 READ(1,*) HEX
0063 WRITE(1,4419)
0064 4419 FORMAT("ENTER 1 TO PRINT INTERMEDIATE ITERATIONS, 0 OTHERWISE: ")
0065 READ(1,*) IGEN
0066 WRITE(1,4420)
0067 4420 FORMAT ( "ENTER LOWEST ACCEPTABLE EIGENVALUE " )
0068 WRITE(1,4421)
0069 4421 FORMAT ( "(0 DEFAULTS TO 1.00): ")
0070 READ(1,*) AYGN
0071 IF(MAXFAC.EQ.0)MAXFAC=30
0072 IF(MAXIT.EQ.0)MAXIT=1
0073 IF(ITMAX.EQ.0)ITMAX=10
0074 IF(EPS.EQ.0)EPS=.01
0075 IF(CRIT.EQ.0)CRIT=.01
0076 IF(AYGN.EQ.0)AYGN=1.00
0077 IF(HEX.EQ.0)GO TO 1492
0078 WRITE(1,4422)
0079 4422 FORMAT ( "ENTER #'S OF VBS TO EXCLUDE, ANY ORDER: ")
0080 READ(1,*) (HELVA(I),I=1,HEX)
0081 1492 CONTINUE
0082 IPUN=0
0083 74 CALL OPEN(IB,IER,IDA,3,0,-2,256)
0084 IF(IER.GE.0)GO TO 745
0085 WRITE(1,4428) IER
0086 4428 FORMAT ( "SRDATA FILE FAILED TO OPEN, IER = ",15 )
0087 STOP
0088 745 DO 10 I=1,30
0089 CALL READF(IB,IER,IBUF)
0090 CALL CODE
0091 READ(IBUF,94) (R(J,I),J=1,30)
0092 10 CONTINUE
0093 94 FORMAT(30(2X,F10.4))
0094 CALL READF(IB,IER,IBUF,256,LEN,61)
0095 CALL CODE
0096 READ(IBUF,94) X
0097 CALL READF(IB,IER,IBUF)
0098 CALL CODE
0099 READ(IBUF,94) COM
0100 CALL READF(IB,IER,IBUF)
0101 CALL CODE
0102 READ(IBUF,808) ((XID(I,J),J=1,4),I=1,30)
0103 808 FORMAT(30(4X,4A2))
0104 CALL CLOSE(IB)
0105 CALL OPEN(IB,IER,ISCR,3,0,-2,256)
0106 IF(HEX.NE.0)CALL REDC(NV,0)
0107 251 DO 252 I=1,30

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0108      CALL CODE
0109      WRITE(IBUF,747)(R(I,J),J=1,30)
0110 747   FORMAT(30(2X,F12.5))
0111 252   CALL WRITF(IB,IER,IBUF)
0112 253   CONTINUE
0113      CALL CLOSE(IB,IER)
0114      WRITE(IUNIT,1894)NV
0115 1894   FORMAT(//5X,"NUMBER OF VARIABLES.....",2X,I2)
0116      DETER=SIHL(NV)
0117      IF(HEX.NE.0)CALL REDC(NV,1)
0118      WRITE(IUNIT,1895)NV,DETER
0119 1895   FORMAT(5X,"RANK OF MATRIX.....",2X,I2//5X,
0120 X"DETERMINANT.....",2X,E14.7)
0121      IF(HEX.EQ.0)GO TO 2600
0122 1896   FORMAT(5X,"VARIABLES ELIMINATED.....",2X,I3)
0123      WRITE(IUNIT,1896)HEX
0124      DO 1897 I=1,HEX
0125      KP=HELV(I)
0126 1897   WRITE(IUNIT,1898)(XID(KP,J),J=1,4)
0127 1898   FORMAT(32X,4A2)
0128 2600   DO 80 I=1,NV
0129 80      X(I)=1.0-(1.0/R(I,I))
0130      NV=NV+HEX
0131      CALL OPEN(IB,IER,ISCR,3,0,-2,256)
0132      DO 2602 I=1,30
0133      CALL READF(IB,IER,IBUF)
0134      CALL CODE
0135 2602   READ(IBUF,747)(R(I,J),J=1,30)
0136      CALL CLOSE(IBUF,IER)
0137      IF(HEX.EQ.0)GO TO 2345
0138      CALL REDC(NV,0)
0139      CALL OPEN(IB,IER,ISCR,3,0,-2,256)
0140      DO 38 I=1,30
0141      CALL CODE
0142 38      WRITE(IBUF,747)(R(I,J),J=1,30)
0143      CALL CLOSE(IB,IER)
0144      WRITE(1,4429)
0145 4429   FORMAT ( "PRINT R MATRIX" )
0146 2345   CALL RPRT(1,NV)
0147      CALL OPEN(IB,IER,IRDX,3,0,-2,256)
0148      IF(IER.GE.0)GO TO 2344
0149      WRITE(1,4430) IER
0150 4430   FORMAT ( "PEDMTX FILE FAILED TO OPEN, IER = ",I5 )
0151      STOP
0152 2344   CALL CODE
0153      WRITE(IBUF,2093)NV
0154      CALL WRITF(IB,IER,IBUF)
0155      DO 2346 I=1,30
0156      CALL CODE
0157      WRITE(IBUF,747)(R(I,J),J=1,30)
0158 2346   CALL WRITF(IB,IER,IBUF)
0159 2347   CALL CODE
0160      WRITE(IBUF,008)((XID(I,J),J=1,4),I=1,30)
0161      CALL WRITF(IB,IER,IBUF)
0162      CALL CLOSE (IB,IER)
0163      IF(NTYP.EQ.2)GO TO 4300
0164      WRITE(1,4431)
0165 4431   FORMAT ( "COMPUTE PRINCIPLE COMPONENTS" )

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0166      CALL EXTC(NV,ITMAX,EPS,IGEN,PCT)
0167      TVAR=0.0
0168      DO 120 J=1,NV
0169      IF(EIGEN(J).LT.AYGN)GO TO 135
0170      TVAR=TVAR+VAR(J)
0171      IF(J.EQ.MAXFAC)GO TO 130
0172 120    CONTINUE
0173 130    NFAC=J
0174      GO TO 140
0175 135    NFAC=J-1
0176      WRITE(1,4432)
0177 4432   FORMAT ( "COMPUTE COMMUNALITY" )
0178 140    DO 150 I=1,NV
0179      COM(I)=0
0180      DO 150 J=1,NFAC
0181      T(I,J)=T(I,J)*SQRT(EIGEN(J))
0182 150    COM(I)=COM(I)+T(I,J)*T(I,J)
0183      IF(IUNIT.EQ.6) WRITE(1,4090)
0184 4090   FORMAT(" PRINCIPAL COMPONENTS SOLUTION OUTPUT NOW ")
0185      WRITE(IUNIT,303)
0186 303    FORMAT(" PRINCIPAL COMPONENTS SOLUTION")
0187      GO TO 200
0188 2001   CALL OFEN(IB,IER,ISCR,3,0,-2.256)
0189      WRITE(1,4433)
0190 4433   FORMAT ( "COMPUTE INVERSE" )
0191 2003   DO 2004 I=1,30
0192      CALL READF(IB,IER,IBUF)
0193      CALL CODE
0194 2004   READ(IBUF,747)(R(I,J),J=1,30)
0195 2005   CONTINUE
0196      CALL CLOSE(IB,IER)
0197      NTP=NTYP+1
0198      DO 90 I=1,NV
0199 90      R(I,I)=X(I)
0200      CALL RPRT (0,NV)
0201      ITER=0
0202 1809   CALL EXTC(NV,ITMAX,EPS,IGEN,PCT)
0203      ITER=ITER+1
0204      TVAR=0
0205      DO 2250 I=1,NFAC
0206 2250   TVAR=TVAR+VAR(I)
0207      DO 2150 I=1,NV
0208      COM(I)=0
0209      DO 2150 J=1,NFAC
0210      T(I,J)=T(I,J)*SQRT(EIGEN(J))
0211 2150   COM(I)=COM(I)+T(I,J)*T(I,J)
0212      IF(IGEN.EQ.0) GO TO 1305
0213      WRITE(IUNIT,506)ITER,(J,X(J),COM(J),J=1,NV)
0214 506    FORMAT(//,5X,"ITERATION ",I3//10X,
0215      X"VARIABLE ESTIMATED OBSERVED"//
0216      $(13X,I3,2X,F10.4,2X,F10.4))
0217      CALL FPRT(NV,NFAC)
0218 1305   IF(ITER.EQ.MAXIT)GO TO 199
0219      DO 160 J=1,NV
0220      IF(ABS(COM(J)-X(J)).GT.CRIT)GO TO 180
0221 160    CONTINUE

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0222      GO TO 200
0223 180   DO 185 J=1,NV
0224 185   X(J)=COM(J)
0225      CALL OPEN(18,IER,ISCR,3,0,-2,256)
0226 1841  DO 1842 I=1,30
0227      CALL READF(18,IER,IBUF)
0228      CALL CODE
0229 1842  READ(18,IBUF,747)(R(I,J),J=1,30)
0230 1843  CONTINUE
0231      CALL CLOSE(18,IER)
0232      DO 186 I=1,NV
0233 186   R(I,I)=X(I)
0234      GO TO 1809
0235 199   CONTINUE
0236      IF(IUNIT.EQ.6) WRITE(1,413)
0237 413   FORMAT("PRINCIPAL FACTORS SOLUTION OUTPUT NOW ")
0238      WRITE(IUNIT,302)
0239 302   FORMAT("      PRINCIPAL FACTOR SOLUTION")
0240 200   Y(1)=VAR(1)
0241      DO 205 J=2,NFAC
0242      JM1=J-1
0243 205   Y(J)=Y(JM1)+VAR(J)
0244      WRITE(IUNIT,206) NFAC,TVAR,PCT
0245 206   FORMAT("//" FACTOR EXTRACTION STATISTICS"//10X
0246      1"NUMBER OF FACTORS.....",5X,IS/10X,
0247      2"PERCENT OF VARIANCE.....",F10.4/10X,
0248      3"ESTIMATED COMMON VARIANCE",F10.4///
0249      415X,"FACTOR",4X,"EIGENVALUE",4X,"PERCENT VARIANCE",4X,
0250      5"CUMULATIVE PERCENT"//)
0251      WRITE(IUNIT,207)(J,EIGEN(J),VAR(J),Y(J),J=1,NFAC)
0252 207   FORMAT(17X,12,4X,F10.4,6X,F10.4,11X,F10.4)
0253      WRITE(IUNIT,209)((XID(I,J),J=1,4),I,COM(I),I=1,NV)
0254 209   FORMAT(4X,"COMMUNALITIES"//" VARIABLE",13X," COMMUNALITY"
0255      1/(5X,4A2,5X,13,F10.4))
0256      WRITE(1,4435)
0257 4435  FORMAT ("PRINT FACTOR MATRIX" )
0258      CALL FPRT(NV,NFAC)
0259      WRITE(1,4436)
0260 4436  FORMAT ("ENTER NAME OF THIS OUTPUT FILE:" )
0261      READ(1,809)IOFILE
0262 809   FORMAT(3A2)
0263      ISIZE(1)=63
0264      ISIZE(2)=53
0265      CALL CREAT(18,IER,IOFILE,ISIZE,2,0,-2,144)
0266      IF(IER.GE.0)GO TO 2094
0267      WRITE(1,4437) IER
0268 4437  FORMAT ("OUTPUT FILE FAILED TO OPEN, IER = ",15 )
0269      STOP
0270 2093  FORMAT(5X,15)
0271 2094  CALL CODE
0272      WRITE(18,IBUF,2093)NFAC
0273      CALL WRITEF(18,IER,18,IBUF)
0274      DO 210 J=1,NFAC
0275      M=0
0276      DO 210 K=1,NV,7

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0277      L=MIN0(K+ 6,NV)
0278      M=M+1
0279      CALL CODE
0280      WRITE(IBUF,2095) J,M,(T(I,J),I=K,L)
0281 210    CALL WRITE(IB,IER,IBUF)
0282 2095   FORMAT(2I3,2X,10F10.7)
0283      CALL LOCF(IB,IER,I1,IRB,I1,JSFC)
0284      ITRUN=JSFC/2 - IRB - 1
0285      CALL CLOSE(IB,IER,ITRUN)
0286      IF(HTYP.EQ.0)GO TO 2001
0287      WRITE(1,4438)
0288 4438   FORMAT ( "ENTER 1 TO CALL VARIMAX  ")
0289      READ(1,*) VARI
0290      IF(VARI.EQ.1)CALL EXEC(9,NVARI)
0291 4300   WRITE(1,4439)
0292 4439   FORMAT ( "ENTER 1 TO CONTINUE, 0 TO END RUN: ")
0293      READ(1,*) NEXT
0294      CALL CLOSE(IB,IER)
0295      IF(NEXT.NE.0)GO TO 1500
0296 3300   STOP
0297      END
0298      SUBROUTINE FPRT(NV,NFAC)
0299      INTEGER XID
0300      COMMON HELVA(30),XID(30,4),NEX
0301      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0302      WRITE(IUNIT,1803)
0303 1803    FORMAT(4X,"FACTOR MATRIX")
0304      DO 640 K=1,NFAC,8
0305      L=MIN0(K+7,NFAC)
0306      WRITE(IUNIT,460)(J,J=K,L)
0307 460    FORMAT(/12X,8(8X,I3))
0308      DO 640 I=1,NV
0309 640    WRITE(IUNIT,385)(XID(I,J),J=1,4),I,(T(I,J),J=K,L)
0310 385    FORMAT(1X,4A2,2X,I3,3X,8(F7.4,4X))
0311      RETURN
0312      END
0313      SUBROUTINE RPRT(HTYP,NV)
0314      INTEGER XID
0315      COMMON HELVA(30),XID(30,4),NEX
0316      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0317      WRITE(IUNIT,355)
0318 355    FORMAT(/5X"CORRELATION MATRIX")
0319 400    DO 440 K=1,NV,8
0320      L=MIN0(K+7,NV)
0321      WRITE(IUNIT,460)(J,J=K,L)
0322 460    FORMAT(/12X,8(8X,I3))
0323      DO 440 I=K,NV
0324      MD=MIN0(L,I)
0325 440    WRITE(IUNIT,385)(XID(I,J),J=1,4),I,(R(I,J),J=K,MD)
0326 385    FORMAT(1X,4A2,2X,I3,3X,8(F7.4,4X))
0327      IF(HTYP.NE.1)WRITE(IUNIT,407)
0328 407    FORMAT(/5X,"NOTE--DIAGONAL ENTRIES ARE SQUARED MULTIPLE
0329      *CORRELATIONS OF EACH VARIABLE WITH THE OTHER N-1 VARIABLES")
0330      RETURN
0331      END

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0332      SUBROUTINE EXTC(MV,ITMAX,EPS,IGEN,PCT)
0333      DIMENSION AIK(30)
0334      INTEGER XID
0335      COMMON MELVA(30),XID(30,4),NEX
0336      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0337      EQUIVALENCE (VAR,AIK)
0338      DO 2 I=1,MV
0339      DO 2 J=1,MV
0340 2      T(I,J)=0
0341      SIG1=0
0342      OFFDSQ=0
0343      DO 5 I=1,MV
0344      SIG1=SIG1+R(I,I)
0345      T(I,I)=1
0346      II=I+1
0347      IF(I.GE.MV)GO TO 6
0348      DO 5 J=II,MV
0349 5      OFFDSQ=OFFDSQ+R(I,J)*R(I,J)
0350 6      S=2*OFFDSQ+SIG1
0351      SIG1D=SIG1
0352      MVV=MV-1
0353      PCT=SIG1D/MV
0354      DO 26 ITER=1,ITMAX
0355      DO 20 I=1,MVV
0356      II=I+1
0357      DO 20 J=II,MV
0358      Q=ABS(R(I,I)-R(J,J))
0359      IF(Q.LE.1.E-7)GO TO 9
0360      IF(ABS(R(I,J)).LE.1.E-7)GO TO 20
0361      P=2*R(I,J)*Q/(R(I,I)-R(J,J))
0362      SPQ=SQRT(P*P+Q*Q)
0363      CSA=SQRT((1+Q/SPQ)/2)
0364      SHA=P/(2*CSA*SPQ)
0365      GO TO 10
0366 9      CSA=1/SQRT(2.0)
0367      SHA=CSA
0368 10      CONTINUE
0369      DO 11 K=1,MV
0370      WT=T(K,I)
0371      T(K,I)=WT*CSA+T(K,J)*SHA
0372 11      T(K,J)=WT*SHA-T(K,J)*CSA
0373      DO 16 K=1,MV
0374      IF(K.GT.J)GO TO 15
0375      AIK(K)=R(I,K)
0376      R(I,K)=CSA*AIK(K)+SHA*R(K,J)
0377      IF(K.EQ.J)GO TO 14
0378      R(J,K)=SHA*AIK(K)-CSA*R(J,K)
0379 14      GO TO 16
0380 15      WT=R(I,K)
0381      R(I,K)=CSA*WT+SHA*R(J,K)
0382      R(J,K)=SHA*WT-CSA*R(J,K)
0383 16      CONTINUE
0384      AIK(J)=SHA*AIK(I)-CSA*AIK(J)
0385      DO 19 K=1,J
0386      IF(K.LE.I)GO TO 18
0387      R(K,J)=SHA*AIK(K)-CSA*R(K,J)

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0388      GO TO 19
0389      18      WT=R(K,I)
0390      R(K,I)=CSA*WT+SNA *R(K,J)
0391      R(K,J)=SNA*WT-CSA*R(K,J)
0392      19      CONTINUE
0393      20      R(I,J)=0
0394      SIG2=0
0395      DO 21 I=1,NV
0396      EIGEN(I)=R(I,I)
0397      21      SIG2=SIG2+EIGEN(I)*EIGEN(I)
0398      IF(1-SIG1/SIG2.GE.EP9)GO TO 26
0399      GO TO 30
0400      26      SIG1=SIG2
0401      30      NVV=NV-1
0402      DO 300 I=1,NVV
0403      IP1=I+1
0404      DO 300 J=IP1,NV
0405      IF(EIGEN(I).GE.EIGEN(J))GO TO 300
0406      TEMP=EIGEN(I)
0407      EIGEN(I)=EIGEN(J)
0408      EIGEN(J)=TEMP
0409      DO 250 L=1,NV
0410      AIK(L)=T(L,I)
0411      T(L,I)=T(L,J)
0412      250      T(L,J)=AIK(L)
0413      300      CONTINUE
0414      DO 35 J=1,NV
0415      35      AIK(J)=EIGEN(J)/NV
0416      IF(IGEN.EQ.0)RETURN
0417      WRITE(IUNIT,204)
0418      204      FORMAT("1",4X,"COMPLETE EIGENSTRUCTURE"//)
0419      DO 205 I=1,NV
0420      205      WRITE(IUNIT,201)I,EIGEN(I),AIK(I)
0421      201      FORMAT(5X,I3,2F10.4)
0422      RETURN
0423      END
0424      SUBROUTINE REDC(NV,NTYP)
0425      INTEGER XID
0426      COMMON HELVA(30),XID(30,4),NEX
0427      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0428      DIMENSION AIK(30)
0429      EQUIVALENCE (AIK,VAR)
0430      WRITE(1,4400)
0431      4400      FORMAT ( "ORDER VARIABLES TO BE ELIMINATED" )
0432      IF(NEX.EQ.1)GO TO 40
0433      NX=NEX-1
0434      DO 300 I=1,NX
0435      IP1=I+1
0436      DO 300 J=IP1,NEX
0437      IF(HELVA(I).GE.HELVA(J))GO TO 300
0438      NTEMP=HELVA(I)
0439      HELVA(I)=HELVA(J)
0440      HELVA(J)=NTEMP
0441      300      CONTINUE

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0442 40 DO 20 I=1,NEX
0443      NZ=NV-1
0444      NEL=NELVA(I)
0445      IF(NEL.EQ.NV)GO TO 19
0446      DO 15 J=NEL,NZ
0447          JP1=J+1
0448      DO 15 K=1,NV
0449 15    R(K,J)=R(K,JP1)
0450      DO 17 K=NEL,NZ
0451          KP1=K+1
0452      DO 17 J=1,NV
0453 17    R(K,J)=R(KP1,J)
0454      WRITE(1,4401)
0455 4401 FORMAT ( "REDUCE VARIABLE NAMES" )
0456      IF(NTYP.EQ.1)GO TO 19
0457      DO 18 J=NEL,NZ
0458          JP1=J+1
0459      DO 18 K=1,4
0460 18    XID(J,K)=XID(JP1,K)
0461 19    NV=NV-1
0462 20    CONTINUE
0463      RETURN
0464      END
0465      FUNCTION SIML(M)
0466      INTEGER XID
0467      COMMON NELVA(30),XID(30,4),NEX
0468      COMMON R(30,30),EIGEN(30),VAR(30),IUNIT
0469      EQUIVALENCE (A,R)
0470      DIMENSION A(30,30)
0471      NEX=0
0472      DET=1
0473      DO 1 J=1,M
0474          PVT=A(J,J)
0475          IF(PVT.GT.0.01)GO TO 25
0476          NEX=NEX+1
0477          NELVA(NEX)=J
0478          GO TO 1
0479 25    DET=DET*PVT
0480          A(J,J)=1
0481      DO 2 K=1,M
0482 2    A(J,K)=A(J,K)/PVT
0483      DO 1 K=1,M
0484          IF(K-J)3,1,3
0485 3    T=A(K,J)
0486          A(K,J)=0
0487      DO 4 L =1,M
0488 4    A(K,L)=A(K,L)-A(J,L)*T
0489 1    CONTINUE
0490      SIML=DET
0491 26    RETURN
0492      END
0493      END$

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VARI (Varimax Location)

Purpose:

VARI accepts input from factor analysis programs and performs normalized varimax rotation on the full factor matrix or sets of the factors.

VARI offers several ways to vary the number of factors rotated. Since it is often not desirable to rotate all the factor obtained in a factor analysis, the user can choose to rotate any number of factors up to the maximum extracted. In addition, sets of various sizes can be rotated in one program run.

Another option allows the first factor to be treated as a general and ignored in rotation. If the first factor is truly a general, so that all variables load on it, the varimax procedures will not be able to achieve a satisfactory "simple structure" solution. If a general is suspected, each factor set can be rotated with and without the first factor to determine differences between the solutions. Factors are rotated pairwise until each rotation required is less than .01 degrees. Each angle of rotation is selected so as to maximize the variance of the loadings squared for each factor. This program can be run apart from FATAA with the 'RU, VARI' command or as an option of FATAA.

Initial Options and Parameters:

1. Option for device output; enter 1 for CRT display or 6 for line printer.
2. Enter number of sets of rotation (maximum is 25, 0 is set to 1). If different number of factors from the same analysis are to be rotated, this number is equal to the total of all such sets (NS).
3. Enter 1 to rotate each set twice, with and without general factor; otherwise, enter 0.
4. Enter the number of factors in each set to be rotated from smallest to largest separated by commas. (NOTE: The first set should have the smallest number of factors, the last should be largest.) If only 1 set, enter number of factors to be rotated in that set.
5. Enter 1 to skip principal component solution and perform only principal axes solution; otherwise, enter 0.

6. If asked for, enter name of file containing factor matrix for principal components solution (from FATAA).
7. Enter name of file containing factor matrix for principal axis solution (from FATAA).
8. Enter 1 to restart program, 0 to stop.

Printout Gives:

1. Number of variables and names (in number of factors principal axis solution).
2. Factor matrix from FATAA.
3. For each set of rotations:
 - a. during solution, the iteration number and the number of rotations greater than 0.01 degree
 - b. when rotation complete
 - 1) number of variables
 - 2) number of factors
 - 3) rotated factor matrix
 - 4) sum of factor loading squared (for each factor)
 - 5) percent of variance (for each factor)
 - 6) total percent of variance
 - 7) NV x NV matrix with original correlations above the diagonal, commonalities in the diagonal, and residual correlation below the diagonal

Test Data:

This program was tested using the same data as SRM30 (See SRM30). Printout of input parameters and statistical output is presented in the factor analysis calculations (See FATAA). The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to four or five digit places instead of ten digits.

*VARI T=00004 IS ON CR00002 USING 00032 BLKS R=0263

```

0001 FTH4
0002 PROGRAM VARI
0003 INTEGER VID
0004 DIMENSION IPFILE(3),IRMX(3),IB(272),IBUF(256)
0005 COMMON R(30,30),H(30),VID(30,4),F(30,10),
0006 XAIJ(30,10),HI(25),NOM(40)
0007 COMMON NV,NF,CON,MX,FH
0008 DATA IRMX/2HRE,2HDM,2HTX/
0009 1095 FORMAT(' PRINCIPAL COMPONENTS SOLUTION')
0010 1096 FORMAT(' PRINCIPAL AXIS SOLUTION')
0011 505 FORMAT(' ITER.',I3,I5,'ROTATIONS OUT OF ',I5,' MORE THAN
0012 $ .01 DEGREES'/)
0013 507 FORMAT(41X,' KAISER VARIMAX ROTATED FACTOR MATRIX'/
0014 $46X,I3,'VARIABLES X',I3,'FACTORS '/)
0015 508 FORMAT(40X,' FACTOR 1 - GENERAL FACTOR'/)
0016 509 FORMAT(/' VAR IDEN #',2X,I3,I3(4X,I3))
0017 510 FORMAT(1X)
0018 511 FORMAT(1X,4A2,I4,14F7.3)
0019 512 FORMAT(/' SUM OF FACTOR LDGS SQD',14F7.3)
0020 513 FORMAT(' PERCENT OF VARIANCE ',14F7.3)
0021 514 FORMAT(/' TOTAL PERCENT OF VARIANCE OF ',I3,' FACTORS = ',F7.3)
0022 515 FORMAT('1')
0023 516 FORMAT(34X,' RESIDUAL CORRELATION MATRIX -',I3,' FACTORS ',
0024 $'EXTRACTED',/
0025 $34X,' UPR RH-ORIGINAL CORRELATIONS'/34X,' DIAGONAL=COMMUNALITY'
0026 $/34X,' LWR LH=RESIDUAL CORRELATIONS'/)
0027 517 FORMAT(' ERROR',I3,' DOES NOT EQUAL ',I3,' MINUS ',I3)
0028 WRITE(1,4400)
0029 4400 FORMAT ('VARIMAX' )
0030 WRITE(1,4401)
0031 4401 FORMAT ('ENTER 1 FOR CRT OUTPUT, 6 FO LPT: ')
0032 READ(1,*) IUNIT
0033 CON=57.295645
0034 1 WRITE(1,4402)
0035 4402 FORMAT ('ENTER # OF SETS OF ROTATION (MAX IS 25): ')
0036 READ(1,*) NS
0037 WRITE(1,4403)
0038 4403 FORMAT ('ROTATE WITH & W/OUT GENERAL FACTOR (1=Y, 0=N): ')
0039 READ(1,*) KGEN
0040 WRITE(1,4404)
0041 4404 FORMAT('ENTER #'S OF FACTORS IN EACH SET TO BE ROTATED',
0042 $'FROM SMALLEST TO LARGEST:')
0043 READ(1,*) (HI(I),I=1,NS)
0044 14 WRITE(1,4405)
0045 4405 FORMAT ('WOULD YOU PREFER TO SKIP THE PRINCIPAL COMPONENT ')
0046 WRITE(1,4406)
0047 4406 FORMAT(' SOLUTION AND PERFORM ONLY THE PRINCIPAL AXIS ')
0048 C,'SOLUTION?')
0049 WRITE(1,4407)
0050 4407 FORMAT ('(1=Y, 0=N): ')

```

```

0051      READ(1,*) JACK
0052      CALL OPEN(IB,IER,IRMX,3,0,-2,256)
0053      IF(IER.GE.0)GO TO 1500
0054      WRITE(1,4408) IER
0055 4408   FORMAT ( 'RECDTX FILE FAILED TO OPEN, IER = ',I5 )
0056      STOP
0057 1500   CALL READF(IB,IER,IBUF)
0058      CALL CODE
0059      READ(IBUF,1501)NV
0060 1501   FORMAT(5X,I5)
0061      WRITE(1,4409) NV
0062 4409   FORMAT ( 'MS1, NV = ',I5 )
0063      DO 1503 I=1,30
0064      CALL READF(IB,IER,IBUF)
0065      CALL CODE
0066      READ(IBUF,1502)((R(I,J),J=1,30)
0067 1502   FORMAT(30(2X,F12.5))
0068 1503   CONTINUE
0069      CALL READF(IB,IER,IBUF)
0070      CALL CODE
0071      READ(IBUF,1504)((VID(I,J),J=1,4),I=1,30)
0072 1504   FORMAT(30(4X,4A2))
0073      CALL CLOSE(IB,IER)
0074 9999   FORMAT(3(2X,10F10.7))
0075      WRITE(IUNIT,9996)
0076 9996   FORMAT(/5X,"VARIABLES UNDER ANALYSIS")
0077 C      WRITE(IUNIT,9999)((R(I,J), J=1,30), I=1,30)
0078      WRITE(IUNIT,1504)((VID(I,J), J=1,4), I=1,NV)
0079 1545   IF(JACK.EQ.0)WRITE (1,432)
0080 432    FORMAT(" ENTER NAME OF FILE CONTAINING FACTOR MATRIX, ",
0081            $"FOR PRINCIPAL COMPONENTS SOLUTION:")
0082      IF(JACK.EQ.1) WRITE(1,433)
0083 433    FORMAT(" ENTER NAME OF FILE CONTAINING FACTOR MATRIX ",
0084            $"FOR PRINCIPAL AXIS SOLUTION:")
0085      READ(1,1505)IPFILE
0086 1505   FORMAT(3A2)
0087      CALL OPEN(IB,IER,IPFILE,3,0,-2,144)
0088      IF(IER.GE.0)GO TO 15055
0089      WRITE(1,4410) IER
0090 4410   FORMAT ( 'FACTOR MATRIX FILE FAILED TO OPEN, IER = ',I5 )
0091      STOP
0092 15055  CALL READF(IB,IER,IBUF)
0093      CALL CODE
0094      READ(IBUF,1511)NFR
0095 1511   FORMAT(5X,I5)
0096      WRITE(1,4411) NFR
0097 4411   FORMAT ( 'MS2,NFR = ',I5 )
0098      WRITE(IUNIT,9997)IPFILE
0099 9997   FORMAT(/11X,3A2//)
0100      DO 1506 J=1, NFR
0101      N=0
0102      DO 1506 K=1,NV,7
0103      L=MIN0(K+6,NV)
0104      N=N+1
0105      CALL READF(IB,IER,IBUF)
0106      CALL CODE

```

```

0107      READ(IBUF,2095) IZ1,IZ2,(AIJ(I,J)),I=K,L)
0108 2095  FORMAT(2I3,2X,10F10.7)
0109 1506  CONTINUE
0110      CALL CLOSE(IB,IER)
0111 15075  IGEN=KGEN
0112      FN=MV
0113      IF(NS.EQ.0)NI(1)=MFR
0114      IF(NS.EQ.0)NS=1
0115      JACK=JACK+1
0116      JG=1
0117      IF(IGEN.NE.0)JG=2
0118      WRITE(1,4413)
0119 4413  FORMAT ('BIG LOOP THRU NS SETS OF SEPARATE ROTATION PROBLEMS')
0120 10    DO 100 L=1,NS
0121      HIT=0
0122      IF(L.EQ.1)KA=1
0123      IF(L.NE.1)KA=NI(L-1)+1
0124      HF=NI(L)
0125      DO 8 J=KA,HF
0126      DO 8 I=1,MV
0127 8      F(I,J)=AIJ(I,J)
0128      IF(IGEN.EQ.0)M=HF*(HF-1)/2
0129      IF(IGEN.NE.0)M=(HF-1)*(HF-2)/2
0130      LK=0
0131      DO 9 I=1,MV
0132      H(I)=0
0133      DO 13 J=JG,HF
0134 13      H(I)=H(I)+F(I,J)**2
0135      H(I)=SQRT(H(I))
0136      DO 9 J=JG,HF
0137 9      F(I,J)=F(I,J)/H(I)
0138 20      MX=M
0139      J=HF
0140 11      LF=J-1
0141      DO 12 K=JG,LF
0142 12      CALL CROT(J,K)
0143      J=J-1
0144      IF(J.GT.JG)GO TO 11
0145      HIT=HIT+1
0146      WRITE(IUNIT,505)HIT,MX,M
0147      IF(MX.GT.0)GO TO 20
0148      DO 30 I=1,MV
0149      DO 30 J=JG,HF
0150 30      F(I,J)=F(I,J)*H(I)
0151      KA=1
0152      KB=14
0153      IF(HF.LT.15)KB=HF
0154 40      IF(JACK.EQ.1)WRITE(IUNIT,1895)
0155      IF(JACK.EQ.2)WRITE(IUNIT,1896)
0156      WRITE(IUNIT,507)MV,HF
0157      IF(IGEN.NE.0)WRITE(IUNIT,508)
0158 60      WRITE(IUNIT,509)(J,J=KA,KB)
0159      WRITE(IUNIT,510)
0160      DO 41 I=1,MV

```

```

0161      IF(LK.EQ.0)WRITE(IUNIT,511)(VID(I,J),J=1,4),I,(F(I,J),J=KA,KB)
0162      IF(LK.NE.0)WRITE(IUNIT,511)(VID(I,J),J=1,4),I,(R(I,J),J=KA,KB)
0163  41      CONTINUE
0164      IF(LK.NE.0)GO TO 44
0165      DO 42 J=1,NF
0166      H(J)=0
0167      DO 42 I=1,NV
0168  42      H(J)=H(J)+F(I,J)**2
0169      WRITE(IUNIT,512)(H(J),J=KA,KB)
0170      SUM=0
0171      DO 43 J=1,NF
0172      H(J)=100*H(J)/FN
0173  43      SUM=SUM+H(J)
0174      WRITE(IUNIT,513)(H(J),J=KA,KB)
0175      WRITE(IUNIT,514)NF,SUM
0176  44      KA=KA+14
0177      KB=KB+14
0178      IF(LK.NE.0)GO TO 55
0179      IF(KB.GE.NF)KB=NF
0180      IF(NF.GE.KA)GO TO 40
0181      WRITE(IUNIT,515)
0182      IF(IVGEN.NE.0)GO TO 100
0183      WRITE(1,4414)
0184  4414     FORMAT ( "OBTAIN RESIDUAL CORRELATIONS" )
0185      DO 52 J=1,NF
0186      DO 52 I=J,NV
0187      SUM=0
0188      DO 51 K=1,NF
0189  51      SUM=SUM+F(I,K)*F(J,K)
0190      IF(I.NE.J)GO TO 53
0191      R(I,I)=SUM
0192      GO TO 52
0193  53      R(I,J)=R(J,I)-SUM
0194  52      CONTINUE
0195      KA=1
0196      KB=14
0197      IF(NV.LT.15)KB=NV
0198      LK=1
0199  50      WRITE(IUNIT,516)NF
0200      GO TO 60
0201  55      IF(KB.GE.NV)KB=NV
0202      IF(NV.GE.KA)GO TO 50
0203      WRITE(IUNIT,515)
0204  100     CONTINUE
0205      IF(IGEN.EQ.0)GO TO 200
0206      IGEN=0
0207      JG=1
0208      GO TO 10
0209  999     WRITE(IUNIT,517)NV,NVC,NE
0210  200     IF(JACK.EQ.1)GO TO 1545
0211      WRITE(1,4415)
0212  4415     FORMAT ( "ENTER 1 TO CONTINUE, 0 TO END RUN: " )
0213      READ(1,*) ICOM
0214      IF(ICOM.EQ.1) GO TO 1
0215      STOP
0216      END

```

```

0217      SUBROUTINE CROT(J,K)
0218      INTEGER VID
0219      COMMON R(30,30),H(30),VID(30,4),F(30,10),
0220      XAID(30,10),NI(25),NOM(48)
0221      COMMON NV,NF,CON,MX,FN
0222      A=0
0223      B=0
0224      C=0
0225      D=0
0226      DO 5 I=1,NV
0227      U=(F(I,J)+F(I,K))*(F(I,J)-F(I,K))
0228      V=2.*F(I,J)*F(I,K)
0229      A=A+U
0230      B=B+V
0231      C=C+(U*U-V*V)
0232      5  D=D+2.*U*V
0233      V=D-(2.*A*B)/FN
0234      U=C-(A*A-B*B)/FN
0235      IF(U.EQ.0)GO TO 84
0236      D=V/U
0237      D=ATAN(D)*CON
0238      IF(V)81,82,82
0239      81 IF(U)83,84,86
0240      82 IF(U)85,84,86
0241      83 V=D-180.
0242      GO TO 87
0243      84 IF(V.EQ.0)GO TO 90
0244      IF(V.LT.0)V=-90.
0245      IF(V.GT.0)V=90
0246      GO TO 87
0247      85 V=180.+D
0248      GO TO 87
0249      86 V=D
0250      87 V=V/4.
0251      IF(ABS(V).GT..01)GO TO 91
0252      90 MX=MX-1
0253      GO TO 21
0254      91 V=V/CON
0255      A=SIN(V)
0256      B=COS(V)
0257      DO 20 I=1,NV
0258      D=F(I,J)*B+F(I,K)*A
0259      F(I,K)=-F(I,J)*A+F(I,K)*B
0260      20 F(I,J)=D
0261      21 CONTINUE
0262      RETURN
0263      END
0264      END$

```

III. NONPARAMETRIC STATISTICS

RANK (Column Ranking)

Purpose:

This program ranks data in a data file and creates a new file to be stored on the disc.

Layout of Design:

Ranking is done across columns independently of rows. In the case of a tied observation average ranks are assigned.

User Considerations and Procedures:

1. RANK expects a data file to be created in a row x column (R x C) matrix form. A printout of raw data would show C (column) elements per line. The created file has the same data format and record length as the original.
2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. Program has four options for data printout. Enter:
 - 1 for printout of raw data only
 - 2 for raw and ranked data printout
 - 3 for ranked data printout
 - 4 for no printout
4. Parameters required:
 - a. number of columns (maximum 100)
 - b. number of rows (maximum 32767)
 - c. raw data file name
 - d. format and record length of data file
 - e. new file name (not same as raw data file)
5. Printout as optioned for only.

Comments:

Ranked data are used for program CHIRA.

RU,RANK
ENTER NUMBER OF COLUMNS
8
ENTER NUMBER OF ROWS
32
ENTER DATA FILE NAME
#FATAA
ENTER DATA FORMAT

(8(2X,F6.2))
ENTER THE RECORD LENGTH AS IN DA30
64
ENTER OUTPUT FILE NAME
GEORGE
ENTER 1 FOR PRINTOUT OF ONLY RAW DATA, 2 FOR RAW DATA AND RANKED DATA,
3 FOR ONLY RANKED DATA, AND 4 FOR NO PRINTOUT AT ALL
2
ENTER 1 FOR CRT DISPLAY, 6 FOR LPTR
6
:

RAW DATA

24.00	81.00	392.00	1024.0	978.00	1101.0	936.00	1120.0
25.00	22.00	181.00	310.00	293.00	346.00	188.00	166.00
27.00	57.00	124.00	172.00	166.00	491.00	154.00	83.00
29.00	36.00	553.00	719.00	605.00	833.00	585.00	346.00
30.00	54.00	1046.0	2221.0	1841.0	2656.0	1062.0	1030.0
31.00	25.00	322.00	522.00	402.00	676.00	261.00	379.00
32.00	78.00	838.00	364.00	222.00	433.00	1014.0	584.00
35.00	80.00	575.00	405.00	456.00	320.00	789.00	320.00
36.00	30.00	835.00	811.00	716.00	824.00	735.00	975.00
37.00	80.00	1001.0	166.00	179.00	154.00	907.00	1065.0
37.00	57.00	1418.0	1706.0	1656.0	1759.0	1024.0	219.00
45.00	74.00	531.00	503.00	581.00	593.00	481.00	593.00
77.00	66.00	218.00	637.00	681.00	591.00	300.00	201.00
80.00	47.00	133.00	109.00	112.00	106.00	166.00	108.00
80.00	80.00	74.00	100.00	115.00	90.00	79.00	68.00
80.00	74.00	550.00	322.00	422.00	204.00	600.00	400.00
18.00	61.00	72.00	429.00	456.00	411.00	405.00	856.00
19.00	18.00	67.00	760.00	856.00	509.00	966.00	3216.0
20.00	80.00	173.00	434.00	311.00	511.00	103.00	139.00
20.00	15.00	209.00	422.00	573.00	250.00	230.00	110.00
22.00	29.00	18.00	1024.0	1114.0	853.00	687.00	671.00
22.00	56.00	98.00	267.00	229.00	341.00	206.00	106.00
22.00	7.00	21.00	752.00	795.00	491.00	1252.0	1308.0
24.00	14.00	292.00	1312.0	1324.0	1296.0	1342.0	1851.0
80.00	51.00	116.00	777.00	1034.0	548.00	880.00	952.00
74.00	51.00	13.00	392.00	390.00	394.00	243.00	265.00
64.00	46.00	19.00	318.00	292.00	348.00	156.00	134.00
60.00	37.00	42.00	703.00	787.00	578.00	142.00	257.00
59.00	18.00	345.00	899.00	778.00	1141.0	424.00	411.00
54.00	14.00	49.00	968.00	747.00	1521.0	925.00	857.00
54.00	71.00	16.00	503.00	421.00	964.00	275.00	226.00
51.00	53.00	15.00	198.00	201.00	193.00	591.00	236.00

RANKED DATA

1.00	2.00	5.00	6.00	4.00	7.00	3.00	8.00
2.00	1.00	4.00	7.00	6.00	8.00	5.00	3.00
1.00	2.00	4.00	7.00	6.00	8.00	5.00	3.00
1.00	2.00	4.00	7.00	6.00	8.00	5.00	3.00
2.00	1.00	4.00	7.00	6.00	8.00	3.00	5.00
1.00	2.00	7.00	4.00	3.00	5.00	8.00	6.00
1.00	2.00	7.00	5.00	6.00	3.50	8.00	3.50
2.00	1.00	7.00	5.00	3.00	6.00	4.00	8.00
1.00	2.00	7.00	4.00	5.00	3.00	6.00	8.00
1.00	2.00	5.00	7.00	6.00	8.00	4.00	3.00
1.00	2.00	5.00	4.00	6.00	7.50	3.00	7.50
2.00	1.00	4.00	7.00	8.00	6.00	5.00	3.00
2.00	1.00	7.00	5.00	6.00	3.00	8.00	4.00
4.50	4.50	2.00	7.00	8.00	6.00	3.00	1.00
2.00	1.00	7.00	4.00	6.00	3.00	8.00	5.00

1.00	2.00	3.00	6.00	7.00	5.00	4.00	8.00
2.00	1.00	3.00	5.00	6.00	4.00	7.00	8.00
1.00	2.00	5.00	7.00	6.00	8.00	3.00	4.00
2.00	1.00	4.00	7.00	8.00	6.00	5.00	3.00
2.00	3.00	1.00	7.00	8.00	6.00	5.00	4.00
1.00	2.00	3.00	7.00	6.00	8.00	5.00	4.00
3.00	1.00	2.00	5.00	6.00	4.00	7.00	8.00
2.00	1.00	3.00	5.00	6.00	4.00	7.00	8.00
2.00	1.00	3.00	5.00	8.00	4.00	6.00	7.00
3.00	2.00	1.00	7.00	6.00	8.00	4.00	5.00
3.00	2.00	1.00	7.00	6.00	8.00	5.00	4.00
3.00	1.00	2.00	7.00	8.00	6.00	4.00	5.00
2.00	1.00	3.00	7.00	6.00	8.00	5.00	4.00
3.00	1.00	2.00	7.00	4.00	8.00	6.00	5.00
2.00	3.00	1.00	7.00	6.00	8.00	5.00	4.00
2.00	3.00	1.00	5.00	6.00	4.00	8.00	7.00

*RANK T=00003 IS ON CR00002 USING 00013 BLKS R=0000

```
0001 FTH4
0002      PROGRAM RANK
0003      COMMON A(100),A1(100),NAME(3),IFMT(20)
0004      COMMON IB(272),IC(272),IBUF(256),ISIZE(2)
0005      DO 109 I=1,100
0006          A(I)=0.
0007          A1(I)=0.
0008 109    CONTINUE
0009      WRITE(1,17)
0010 17    FORMAT(" ENTER NUMBER OF COLUMNS ")
0011      READ(1,*) NC
0012      WRITE(1,16)
0013 16    FORMAT(" ENTER NUMBER OF ROWS ")
0014      READ(1,*) NR
0015      WRITE(1,15)
0016 15    FORMAT(" ENTER DATA FILENAME ")
0017      READ(1,1) NAME
0018 1      FORMAT(3A2)
0019      WRITE(1,14)
0020 14    FORMAT(" ENTER DATA FORMAT ")
0021      READ(1,11) IFMT
0022 11    FORMAT(20A2)
0023      WRITE(1,88)
0024 88    FORMAT(" ENTER THE RECORD LENGTH AS IN DA30 ")
0025      READ(1,*) LENGTH
0026      LEN=LENGTH/2
0027      IF((LEN*2).NE.LENGTH) LEN=LEN+1
0028      LENGTH=LEN
0029      IDCBS=LENGTH
0030      IF(LENGTH.LT.144) IDCBS=144
0031      CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
0032      IF(IER.GE.0) GO TO 543
0033      WRITE(1,566) NAME,IER
0034 566   FORMAT(5X,3A2," FAILED TO OPEN , IER = ",I5)
0035      STOP 566
0036 543   WRITE(1,12)
0037 12    FORMAT(" ENTER OUTPUT FILENAME ")
0038      READ(1,1) NAME
0039      ISIZE(2)=LENGTH
0040      SIZE=LENGTH
0041      XSU=NR
0042      SIZE=XSU*SIZE/128. + 1.
0043      ISIZE(1)=SIZE
0044      CALL CREAT(IC,IER,NAME,ISIZE,2,0,-2,IDCBS)
0045      IF(IER.GE.0) GO TO 350
0046      WRITE(1,566) NAME,IER
0047      STOP 567
0048 350   DO 100 M5=1,NR
0049          L1=1
0050          N=0
0051          CALL READF(IB,IER,IBUF)
0052          CALL CODE
```

```

0053      READ(IBUF,IFMT)(A(K),K=1,NC)
0054      2      ALOW=9999.99
0055      N=N+L1
0056      DO 3 K=1,NC
0057      IF(A(K).EQ.9999.99)GO TO 3
0058      IF(A(K).LT.ALOW)ALOW=A(K)
0059      3      CONTINUE
0060      IF(ALOW.EQ.9999.99)GO TO 10
0061      L1=0
0062      C=0
0063      DO 5 K=1,NC
0064      IF(A(K).NE.ALOW)GO TO 5
0065      L1=L1+1
0066      C=C+N+L1-1
0067      5      CONTINUE
0068      C=C/L1
0069      DO 4 K=1,NC
0070      IF(A(K).NE.ALOW)GO TO 4
0071      A1(K)=C
0072      A(K)=9999.99
0073      4      CONTINUE
0074      GO TO 2
0075      10      CALL CODE
0076      WRITE(IBUF,IFMT)(A1(K),K=1,NC)
0077      CALL WRITF(IC,IER,IBUF)
0078      100     CONTINUE
0079      WRITE(1,159)
0080      159     FORMAT("ENTER 1 FOR PRINTOUT OF ONLY RAW DATA,2 FOR RAW DATA ",
0081      $/, " AND RANKED DATA,3 FOR ONLY RANKED DATA , AND 4 FOR NO ",/
0082      $, "PRINTOUT AT ALL")
0083      READ(1,*) IPTO
0084      IF((IPTO.LT.1).OR.(IPTO.GE.4)) GO TO 32
0085      WRITE(1,160)
0086      160     FORMAT("ENTER 1 FOR CRT DISPLAY, 6 FOR LPTR")
0087      READ(1,*) IUNIT
0088      CALL RWNDF(19)
0089      CALL RWNDF(IC)
0090      IF(IPTO.EQ.3) GO TO 788
0091      WRITE(IUNIT,209)
0092      209     FORMAT(//,5X,"RAW DATA",//)
0093      DO 137 I=1,NR
0094      CALL READF(18,IER,IBUF)
0095      CALL CODE
0096      READ(IBUF,IFMT) (A(K),K=1,NC)
0097      137     WRITE(IUNIT,IFMT) (A(K),K=1,NC)
0098      IF(IPTO.EQ.1) GO TO 32
0099      788     WRITE(IUNIT,237)
0100      237     FORMAT(///,5X,"RANKED DATA ",/)
0101      DO 273 I=1,NR
0102      CALL READF(IC,IER,IBUF)
0103      CALL CODE
0104      READ(IBUF,IFMT) (A1(K),K=1,NC)
0105      273     WRITE(IUNIT,391) (A1(K),K=1,NC)
0106      391     FORMAT(10(1X,F6.2))
0107      32      CALL CLOSE (18,IER)
0108      CALL CLOSE (IC,IER)
0109      END
0110      END$

```

ORANK (Matrix Ranking)

Purpose:

This program ranks data in a data file and creates a new file to be stored on disc.

Layout of Design:

Unlike the program RANK, ranking is done for entire data set. In case of tied observations, ranks are assigned randomly.

User Considerations and Procedures:

1. Program expects data file to be created in a row x column ($R \times C$) matrix format. A printout of raw data would have C (column) elements per line. The created data file would be in $R \times C$ matrix form with different data format and record length.
2. Parameters required:
 - a. raw data file name
 - b. ranked data file name
 - c. raw data format and record length
 - d. ranked data format and record length
 - e. number of records (rows) (see comments)
 - f. number of columns (see comments)
3. There is no printout of the ranked data.

Comments:

The maximum size of parameters, row (R) and column (C), is as follows:

1. $C \leq 30$
2. $R * C \leq 2500$

```

RU,ORANK
PROGRAM TO RANK ENTIRE DATA SET BY ROWS AND COLUMNS
ENTER NAME OF INPUT DATA FILE
#FATAA
ENTER NAME OF OUTPUT DATA FILE
#UWF
ENTER INPUT DATA FILE FORMAT
(8(2X,F6.2))
ENTER OUTPUT DATA FILE FORMAT
(8(2X,F6.2))
ENTER THE RECORD LENGTH AS IN DA30
64
ENTER THE OUTPUT RECORD LENGTH AS IN DA30
64
ENTER IN NUMBER OF RECORDS
32
ENTER IN NUMBER OF VARIABLES
8
  CRANK : STOP    0000
:LL,6
:LI,#FATAA,A
:LI,#UWF,A
:

```


*ORANK T=00003 IS ON CR00002 USING 00012 BLKS R=0000

```

0001  FTH4,L
0002      PROGRAM ORANK
0003      COMMON Y(2500),IB(272),IC(272),IBUF(256),ICUF(256),NAME(3),
0004      &INAME(3),IFMT(20),IFMT2(20),X(30),JJ(30),IREC,IVAR,ISIZE(2)
0005      COMMON Z(30)
0006      WRITE(1,1)
0007  1    FORMAT("PROGRAM TO RANK ENTIRE DATA SET BY  ROWS AND COLUMNS")
0008      WRITE(1,2)
0009  2    FORMAT("ENTER NAME OF INPUT DATA FILE")
0010      READ(1,3) NAME
0011  3    FORMAT(3A2)
0012      WRITE(1,4)
0013  4    FORMAT("ENTER NAME OF OUTPUT DATA FILE")
0014      READ(1,3) INAME
0015      WRITE(1,5)
0016  5    FORMAT("ENTER INPUT DATA FILE FORMAT")
0017      READ(1,6) IFMT
0018  6    FORMAT(20A2)
0019      WRITE(1,7)
0020  7    FORMAT("ENTER OUTPUT DATA FILE FORMAT")
0021      READ(1,6) IFMT2
0022      WRITE(1,8)
0023  88   FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0024      READ(1,*) LENGTH
0025      LEN=LENGTH/2
0026      IF((LEN*2).NE.LENGTH) LEN=LEN+1
0027      LENGTH=LEN
0028      IDCBS=LENGTH
0029      IF(LENGTH.LT.144) IDCBS=144
0030      CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
0031      IF(IER.GT.0) GO TO 8
0032      WRITE(1,9) NAME,IER
0033  9    FORMAT(3A2," FAILED TO OPEN , IER = ",I5)
0034      STOP 1
0035  8    CONTINUE
0036      WRITE(1,89)
0037  89   FORMAT(" ENTER THE OUTPUT RECORD LENGTH AS IN DA30")
0038      READ(1,*) LENGTH
0039      LEN=LENGTH/2
0040      IF((LEN*2).NE.LENGTH) LEN=LEN+1
0041      LENGTH=LEN
0042      IDCBS=LENGTH
0043      IF(LENGTH.LT.144) IDCBS=144
0044      WRITE(1,10)
0045  10   FORMAT("ENTER IN NUMBER OF RECORDS")
0046      READ(1,*) IREC
0047      WRITE(1,11)
0048  11   FORMAT("ENTER IN NUMBER OF VARIABLES")
0049      READ(1,*) IVAR
0050      ITOTAL=IREC*IVAR

```

```

0051      SIZE=LENGTH
0052      ISIZE(2)=LENGTH
0053      XG=IREC
0054      SIZE=XG*SIZE/128. + 1
0055      ISIZE(1)=SIZE
0056      CALL CREAT(IC,IER,INAME,ISIZE,2,0,-2,IDCBS)
0057      IF( IER.LT.0) WRITE(1,9) INAME,IER
0058      IF( IER.LT.0) CALL CLOSE(IB)
0059      IF( IER.LT.0) STOP
0060      DO 12 J=1,IREC
0061      CALL READF(IB,IER,IBUF)
0062      CALL CODE
0063      READ(IBUF,IFMT)(X(I),I=1,IVAR)
0064      DO 13 I=1,IVAR
0065      L=(J-1)*IVAR+I
0066      13 Y(L)=X(I)
0067      12 CONTINUE
0068      CALL SORT(ITOTAL)
0069      CALL RWNDF(IB)
0070      DO 50 K=1,IREC
0071      CALL READF(IB,IER,IBUF)
0072      CALL CODE
0073      READ(IBUF,IFMT)(X(I3),I3=1,IVAR)
0074      DO 51 J=1,IVAR
0075      DO 52 I=1,ITOTAL
0076      IF(X(J).NE.Y(I)) GO TO 52
0077      Y(I)=-99.363
0078      Z(J)=I
0079      GO TO 51
0080      52 CONTINUE
0081      51 CONTINUE
0082      CALL CODE
0083      WRITE(ICUF,IFMT2)(Z(I4),I4=1,IVAR)
0084      CALL WRITF(IC,IER,ICUF)
0085      50 CONTINUE
0086      26 CALL CLOSE(IB)
0087      CALL CLOSE(IC)
0088      STOP
0089      END
0090      SUBROUTINE SORT(N)
0091      COMMON Y(2500)
0092      N1=N-1
0093      DO 1 I=1,N1
0094      J=1+I
0095      DO 2 K=J,N
0096      IF(Y(I).LE.Y(K)) GO TO 2
0097      TEMP=Y(I)
0098      Y(I)=Y(K)
0099      Y(K)=TEMP
0100      2 CONTINUE
0101      1 CONTINUE
0102      END
0103      END$

```

STACH (Nonparametric Descriptive Statistics)

Purpose:

This program is a descriptive package for nonparametric data which includes the following statistics: mean, median, standard deviation, middle 80 percentile range, semi-interquartile range, alpha 3, and alpha 4. This program also performs a chi-squared goodness of fit test for testing normality based on a frequency histogram of the raw data.

Mathematical Model:

The program creates a histogram, with a specified number of classes, from the raw data. Then, it standardizes each variable by the mean and variance of the histogram. The chi-squared value is determined by comparison of the histogram class frequency against the expected standard normal class frequency. This is done by:

$$\chi^2 = \sum_{i=1}^N \left[\frac{(f_i - E(f_i))^2}{E(f_i)} \right]$$

where:

f_i = actual frequency

$E(f_i)$ = expected frequency

N = number of classes

User Considerations and Procedures:

1. Program expects data created in matrix form. Each record contains X_{ij} ; $j = 1, M$; where M = number of variables in data set; and i = the observation (or subject number). A printout of raw data would show m data points per line.
2. The data analysis can be either displayed on the CRT or hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. A printout of the histogram can be obtained. Enter 1 if a histogram printout is desired, 0 for no printout.

5. Program asked if test for normality is wanted. Respond 1 for yes. If only the histogram and/or different nonparametric statistics are desired, respond 0.
6. An option for IAP (rerun program) exists, respond 1 if you wish to rerun program, 0 for no.
7. A printout if the expected normal frequencies can be obtained. Enter 1 if desired, 0 if not.
8. Parameters required:
 - a. number of variables in data file (maximum 100)
 - b. number of subjects (maximum 32767)
 - c. number of classes in histogram (maximum 25)
 - d. number of variables to be analyzed (maximum 100)
 - e. enter variable numbers which are to be analyzed
 - f. name of data file
 - g. format and record length of data file (see DA30)
9. Printout gives:
 - a. number of observations, mean, median, mode, standard deviation, middle 80 percent range, semi-interquartile range, alpha 3, alpha 4, for each requested variable
 - b. frequency histogram (optional)
 - c. expected normal frequency (optional)
 - d. chi-squared value and degrees of freedom (optional)

Comments:

The results of the chi-squared test gives the calculated chi-squared value with its degrees of freedom. To determine the probability level go to a chi-squared table. This test is very conservative; data have to be very unnormal to reject null hypothesis.

Test Data:

The data used to test this program is the same as SRM30 (See SRM30). This program was hand-tested using a Texas Instrument calculator software program. The program uses double precision for most variables.

RU,STACH
ENTER NUMBER OF VARIABLES
8
ENTER THE NUMBER OF VARIABLES TO BE ANALYZED
1
ENTER NUMBER OF SUBJECTS
64
ENTER # OF CLASSES IN THE POLYGON; MAX=25
3
POLYGON WANTED? 1=YES, 0=NO
1
TEST FOR NORMALITY WANTED? 1=YES, 0=NO
1
IAP 1=YES, 0 = NO
0
ENTER DATA FILE NAME
#STACH
ENTER DATA FORMAT
(8(2X,F6.2))
ENTER THE RECORD LENGTH AS IN DA30
64
ENTER 1 FOR CRT OUTPUT, 6 FOR LP
6
ENTER NUMBER OF VARIABLES TO BE INCLUDED
1
ENTER 1 FOR RAW DATA PRINTOUT
0
ENTER 1 FOR PRINTOUT OF EXPECTED VALUES
1
:

STATISTICS FOR VARIABLE		1
NUMBER	=	64
MEAN	=	42.750
MEDIAN	=	35.500
MODE	=	25.500
STANDARD DEVIATION	=	21.034
MIDDLE 80 PCT RANGE	=	57.173
SEMI INTERQUARTILE RANGE	=	18.133
ALPHA 3	=	.561
ALPHA 4	=	1.813

FREQUENCY POLYGON VARIABLE			1
17.500	25.500	XXXXXXXXXXXXXXXXXXXXX	
25.500	33.500	XXXXXXXXXXXX	
33.500	41.500	XXXXXXXXXX	
41.500	49.500	XX	
49.500	57.500	XXXXXX	
57.500	65.500	XXXXXX	
65.500	73.500		
73.500	81.500	XXXXXXXXXXXXX	

EXPECTED NORMAL VALUES

13.1892185
7.9343309
9.3600349
9.5714035
8.4840889
6.5187569
4.3416157
4.6005507

VARIABLE 1 CHI SQUARED FOR NORMALITY = 12.056,DF = 6

CK 3
CK 4
CK 5

*STACH T=00004 IS ON CR00002 USING 00028 BLKS R=0243

```

0001 FTH4
0002 PROGRAM STACH
0003 DOUBLE PRECISION Z1,T1,V(25)
0004 COMMON SC(100),IBUF(256),IB(272),NJ(2),NAME(3),IFMT(20),
0005 CNWL(100)
0006 $.LINE(100),FR(25),VLL(25),V,THE(25)
0007 INTEGER BLANK,EX
0008 DATA BLANK/2H /,EX/2HX /
0009 101 CONTINUE
0010 WRITE(1,395)
0011 395 FORMAT("ENTER NUMBER OF VARIABLES")
0012 READ(1,*) NV
0013 WRITE(1,298)
0014 298 FORMAT("ENTER THE NUMBER OF VARIABLES TO BE ANALYZED")
0015 READ(1,*) NW
0016 WRITE(1,299)
0017 299 FORMAT("ENTER NUMBER OF SUBJECTS")
0018 READ(1,*) NP
0019 WRITE(1,330)
0020 330 FORMAT("ENTER # OF CLASSES IN THE POLYGON ; MAX=25")
0021 READ(1,*) NC
0022 WRITE(1,332)
0023 332 FORMAT("POLYGON WANTED ? 1 = YES 0=NO")
0024 READ(1,*) NJ(1)
0025 WRITE(1,331)
0026 331 FORMAT("TEST FOR NORMALITY WANTED ? 1=YES 0=NO")
0027 READ(1,*) NJ(2)
0028 WRITE(1,334)
0029 334 FORMAT(" IAP 1=YES 0=NO")
0030 READ(1,*) IAP
0031 WRITE(1,333)
0032 333 FORMAT("ENTER DATA FILE NAME")
0033 READ(1,1002) NAME
0034 1002 FORMAT(3A2)
0035 WRITE(1,1003)
0036 1003 FORMAT("ENTER DATA FORMAT")
0037 READ(1,1004) IFMT
0038 1004 FORMAT(20A2)
0039 WRITE(1,88)
0040 88 FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0041 READ(1,*) LENGTH
0042 LEN=LENGTH/2
0043 IF((LEN*2).NE.LENGTH) LEN=LEN+1
0044 LENGTH=LEN
0045 IDCBS=LENGTH
0046 IF(LENGTH.LT.144) IDCBS=144
0047 CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
0048 IF(IER.GE.0) GO TO 73
0049 WRITE(1,39) NAME,IER
0050 39 FORMAT(3A2," FAILED TO OPEN , IER = ",I3)

```

```

0051      STOP
0052  73      WRITE(1,98)
0053  98      FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LP")
0054      READ(1,*) IUNIT
0055      WRITE(1,934)
0056  934     FORMAT("ENTER NUMBER OF VARIABLES TO BE INCLUDED")
0057      READ(1,*) (NWL(I),I=1,NV)
0058      WRITE(1,437)
0059  437     FORMAT("ENTER 1 FOR RAW DATA PRINTOUT")
0060      READ(1,*) IPTO
0061      WRITE(1,3487)
0062  3487    FORMAT("ENTER 1 FOR PRINTOUT OF EXPECTED VALUES")
0063      READ(1,*) ITP
0064      DO 231 I31=1,NV
0065      SUMX=0.
0066      SUMX2=0.
0067      DO 4 I=1,NP
0068      CALL READF(IB,IER,IBUF)
0069      CALL CODE
0070      READ(IBUF,IFMT) (SC(J),J=1,NV)
0071      IF (IPTO.EQ.1) WRITE(IUNIT,IFMT) (SC(J),J=1,NV)
0072      X=SC(NWL(I31))
0073      SUMX=SUMX+X
0074      SUMX2=SUMX2+X*X
0075      IF(I.NE.1)GO TO 400
0076      XL=X
0077      XH=X
0078  400     IF(X.LT.XL) XL=X
0079          IF(X.GT.XH) XH=X
0080  4        CONTINUE
0081      SNC=NC
0082      IPTO=0
0083      SMP=NP
0084      RINC=XH-XL+1
0085      CI=RINC/SNC
0086      NCI=CI+.99999
0087      CI=NCI
0088      DO 7 K=1,NC
0089  7        FR(K)=0
0090          DO 8 K=1,NC
0091          FK=K
0092  8        YLL(K)=XL-.5+(FK-1)*CI
0093          CALL RWNDF(IB)
0094          DO 9 I=1,NP
0095          CALL READF(IB,IER,IBUF)
0096          CALL CODE
0097          READ(IBUF,IFMT) (SC(J),J=1,NV)
0098          XC=SC(NWL(I31))
0099          KK=(XC-YLL(1))/CI+1
0100  10       FR(KK)=FR(KK)+1
0101  9        CONTINUE

```



```

0102      COD1=.1*SNP
0103      COQ1=.25*SNP
0104      COD5=.5*SNP
0105      COQ3=.75*SNP
0106      COD9=.9*SNP
0107      SX=0
0108      SSX=0
0109      SCX=0
0110      SQX=0
0111      DO 12 J=1,NC
0112      SMC=J
0113      AA=VLL(1)+CI*(SMC-.5)
0114      SX=SX+FR(J)*AA
0115      SSX=SSX+FR(J)*(AA**2)
0116      SCX=SCX+FR(J)*(AA**3)
0117 12    SQX=SQX+FR(J)*(AA**4)
0118      CTM=SX/SNP
0119      SIG=SQRT(SNP*SSX-SX**2)/SNP
0120      ALPH=SCX-3*CTM*SSX+2*SNP*(CTM**3)
0121      ALPH=ALPH/(SNP*(SIG**3))
0122      BET=SQX-4*SCX*CTM+6*SSX*(CTM**2)-3*SNP*(CTM**4)
0123      BET=BET/(SNP*(SIG**4))
0124      AA=0
0125      DO 14 J=1,NC
0126      BB=AA+FR(J)
0127      IF(BB.GE.COD1)GO TO 15
0128      AA=BB
0129      GO TO 14
0130 15    DE1=VLL(J)+CI*(COD1-AA)/FR(J)
0131      GO TO 16
0132 14    CONTINUE
0133 16    AA=0
0134      WRITE(IUNIT,663)
0135 663    FORMAT('  CK 3  ')
0136      DO 17 J=1,NC
0137      BB=AA+FR(J)
0138      IF(BB.GE.COQ1)GO TO 18
0139      AA=BB
0140      GO TO 17
0141 18    QT1=VLL(J)+CI*(COQ1-AA)/FR(J)
0142      GO TO 19
0143 17    CONTINUE
0144 19    AA=0
0145      DO 20 J=1,NC
0146      BB=AA+FR(J)
0147      IF(BB.GE.COD5)GO TO 21
0148      AA=BB
0149      GO TO 20
0150 21    DE5=VLL(J)+CI*(COD5-AA)/FR(J)
0151      GO TO 22
0152 20    CONTINUE
0153 22    AA=0
0154      DO 23 J=1,NC
0155      BB=AA+FR(J)
0156      IF(BB.GE.COQ3)GO TO 24

```

```

0157      AA=BB
0158      GO TO 23
0159 24      QT3=VLL(J)+CI*(COQ3-AA)/FR(J)
0160      GO TO 25
0161 23      CONTINUE
0162 25      AA=0
0163      WRITE(IUNIT,664)
0164 664      FORMAT("      CK 4      ")
0165      DO 26 J=1,NC
0166      BB=AA+FR(J)
0167      IF(BB.GE.COD9)GO TO 27
0168      AA=BB
0169      GO TO 26
0170 27      DE9=VLL(J)+CI*(COD9-AA)/FR(J)
0171      GO TO 28
0172 26      CONTINUE
0173 28      RM80=DE9-DE1
0174      SIG=(QT3-QT1)/2
0175      AA=FR(1)
0176      MX=1
0177      DO 29 J=1,NC
0178      IF(FR(J).GT.AA)MX=J
0179      IF(FR(J).GT.AA)AA=FR(J)
0180 29      CONTINUE
0181      WRITE(IUNIT,667)
0182 667      FORMAT("      CK 5      ")
0183      MNX=MN+1
0184      MNX=MN-1
0185      RAT=(FR(MNX))/(FR(MNX)+FR(MN))
0186      VMOD=VLL(MN)+RAT*CI
0187      I9=IUNIT
0188      WRITE(I9,30)I31,NP,CTM,DE5,VMOD,SIG,RM80,SIG,ALPH,BET
0189 30      FORMAT(1H1,"STATISTICS FOR VARIABLE",I3/1X,"NUMBER  =",I4/
0190      X1X,"MEAN  =",F7.3/1X,"MEDIAN=",F7.3/1X,"MODE  =",F7.3/1X,
0191      X"STANDARD DEVIATION  =",F7.3/1X,"MIDDLE 80 PCT RANGE  ",
0192      XF7.3/1X,
0193      X"SEMI INTERQUARTILE RANGE  =",F7.3/1X,"ALPHA 3  =",F7.3/1X,
0194      X"ALPHA 4  =",F7.3)
0195      IF(NJ(1).EQ.0)GO TO 200
0196      WRITE(IUNIT,31)I31
0197 31      FORMAT(1H1,"FREQUENCY POLYGON VARIABLE  ",I3)
0198      DO 32 J=1,NC
0199      DO 33 K=1,100
0200 33      LINE(K)=BLANK
0201      NBAR=FR(J)
0202      IF(NBAR.EQ.0)GO TO 100
0203      DO 34 K=1,NBAR
0204 34      LINE(K)=EX
0205 100      HL=VLL(J)+CI
0206      WRITE(IUNIT,35)VLL(J),HL,(LINE(K),K=1,100)
0207 35      FORMAT(1H0,F7.3,1H ,F7.3,2X,100A1)
0208 32      CONTINUE
0209 200      IF(NJ(2).EQ.0)GO TO 11

```

```

0210      CHI=0
0211      C      SIG=SQRT((SUMX2-SUMX*SUMX/SNP)/(SNP-1.))
0212      C      CTM=SUMX/SNP
0213      DO 93 IJ=1,NC
0214      Z1=(VLL(IJ)-CTM)/SIG
0215      CALL YNORM(Z1,T1)
0216      93      V(IJ)=T1
0217      NCC=NC-1
0218      THE(1)=SNP*V(2)
0219      DO 733 IV=2,NCC
0220      J3=IV+1
0221      733      THE(IV)=SNP*DABS(V(J3)-V(IV))
0222      734      FORMAT(5X,F14.7)
0223      THE(NC)=SNP*DABS(1-V(NC))
0224      IF(ITP.EQ.1) WRITE(IUNIT,9812)
0225      9812      FORMAT(" EXPECTED NORMAL VALUES ",5X,F14.7)
0226      IF(ITP.EQ.1) WRITE(IUNIT,734) (THE(IK),IK=1,NC)
0227      DO 248 J=1,NC
0228      IF(J.EQ.NC)GO TO 40
0229      IF(THE(J).GE.5)GO TO 40
0230      K=J+1
0231      NCC=NCC-1
0232      THE(K)=THE(J)+THE(K)
0233      FR(K)=FR(K)+FR(J)
0234      GO TO 248
0235      40      CHI=CHI+((FR(J)-THE(J))*2)/THE(J)
0236      248      CONTINUE
0237      WRITE(IUNIT,41)I31,CHI,NCC
0238      41      FORMAT(1H0/1X,"VARIABLE",I3," CHI SQUARED FOR NORMALITY=",F7.3,
0239      X",DF=",I3)
0240      11      CONTINUE
0241      231      CALL RWNDF(IB)
0242      CALL CLOSE(IB)
0243      IF(IAP.EQ.1) GO TO 101
0244      END
0245      END*

```

CHIRA (Coefficient of Concordance)

Purpose:

This program finds Kendall's coefficient of concordance, W , tests for its significance, and provides reliability figures of the ranked data. Wilcoxin sign rank, Z , can also be obtained for all variable combinations.

Mathematical Model and Layout of Design:

In our layout, we have N objects (or individuals) ranked in K -sets. Each set is ranked independently of each other.

	1	2	3		N
1	r_{11}	r_{12}	r_{13}		r_{1n}
2	r_{21}	r_{22}	r_{23}		r_{2n}
3	r_{31}	r_{32}	r_{33}		r_{3n}
.	.	.	.		.
.	.	.	.		.
.	.	.	.		.
.	.	.	.		.
k	r_{k1}	r_{k2}	r_{k3}		r_{kn}

1. Mount a magnetic tape! (any scratch tape will do).
2. Program expects ranked data in $k \times N$ matrix form to have been created (see program RANK). A printout of data would show N observations per line.
3. The data analysis can be either displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
4. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#3).
5. Program asks if Wilcoxin sign rank, Z , is desired. Enter 1 for yes, 0 for no. NOTE: The program prints out the Wilcoxin Z for all pairs of variables and an approximate probability. The number of signed ranks = $N(N-1)/2$.

6. Parameters required:

- a. number of columns = N = (maximum 70)
- b. number of rows = k = (maximum 30)
- c. enter 1 for correction of ties (Not to correct for ties is incorrect! If data have been created using RANK, ties have already been assigned average ranks.)
- d. name of ranked data file
- e. format and record length of data file (see DA30)

7. Printout gives:

- a. raw data (optional)
- b. Wilcoxin Z (optional)
- c. Kendall's W , chi-square with degrees of freedom, average row reliability, and total reliability
- d. $\underline{S}$, sum of squared deviations from mean of n th object (see comments)

Comments:

The hypothesis being tested with Kendall's W is whether k -sets of rankings are independent. Kendall's W expresses the degree of agreement among the k -sets (judges, etc.) in ranking the N objects. When $N > 7$, W is related to the chi-squared distribution by

$$X^2 = k(N - 1)W \text{ with } df = N - 1.$$

The program gives the X^2 value in all cases. If $N \leq 7$ this value will be incorrect. For critical values in this case ($N \leq 7$) see S. Siegel, Nonparametric Statistics for the Behavioral Sciences, Table R, P. 286. This table gives critical values of $\underline{S}$, which the program prints out. The table shows minimum critical values of $\underline{S}$ for the .05 and .01 level of significance.

If $N > 7$, compare the chi-square for R , printed by program, with the chi-square value from any table of critical values (i.e., Table C, P. 249, in S. Siegel).

The average row reliability equals $(kW - 1)/(W(k - 1))$. Total reliability equals $(kW - 1)/(W(k - 1))$.

In Wilcoxin Z , the hypothesis we are testing is whether 2 variables (in each Z) differ.

Test Data:

This program was tested using data from S. Siegel, Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill, 1956, p. 233-237.

RU,CHIRA
 ENTER DATA FILE NAME
 #CHIRA
 DO YOU WISH TO COMPUTE WITH TIES 1=YES, 0=NO
 1
 NUMBER OF COLUMNS (MAX 70) :
 4
 NUMBER OF ROWS (MAX 30):
 10
 ENTER DATA FORMAT
 (4(1X,F3.0))
 ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT
 6
 ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0
 1
 DO YOU WANT WILCOXIN SIGN RANK Z?, 1=YES, 0=NO
 1
 ENTER THE RECORD LENGTH AS IN DA30
 16
 CHIR : STOP 0000
 CTAPE ABORTED
 :

RAW DATA

1.0000	2.0000	3.0000	4.0000
1.0000	2.0000	3.0000	4.0000
1.0000	2.0000	3.0000	4.0000
2.0000	1.0000	3.0000	4.0000
2.0000	1.0000	3.0000	4.0000
1.0000	2.0000	3.0000	4.0000
1.0000	3.0000	2.0000	4.0000
1.0000	2.0000	3.0000	4.0000
2.0000	1.0000	4.0000	3.0000
1.0000	2.0000	4.0000	3.0000

DATA CALCULATED WITH CORRECTIONS FOR TIES

CHI SQUARE FOR R = 23.880, DEGREES OF FREEDOM = 3

KENDALL'S W = .796

AVERAGE ROW RELIABILITY = .773 TOTAL RELIABILITY = .972

8 = 398.00000

VAR 1	AND VAR 2	WILCOXIN SIGNED RANK Z =	-1.274	# OF PAIRS =	10	ALPHA LEVEL SIGNIFICANCE =	.50
VAR 1	AND VAR 3	WILCOXIN SIGNED RANK Z =	-2.803	# OF PAIRS =	10	ALPHA LEVEL SIGNIFICANCE =	.01
VAR 1	AND VAR 4	WILCOXIN SIGNED RANK Z =	-2.803	# OF PAIRS =	10	ALPHA LEVEL SIGNIFICANCE =	.01
VAR 2	AND VAR 3	WILCOXIN SIGNED RANK Z =	-2.446	# OF PAIRS =	10	ALPHA LEVEL SIGNIFICANCE =	.02
VAR 2	AND VAR 4	WILCOXIN SIGNED RANK Z =	-2.803	# OF PAIRS =	10	ALPHA LEVEL SIGNIFICANCE =	.01
VAR 3	AND VAR 4	WILCOXIN SIGNED RANK Z =	-1.784	# OF PAIRS =	10	ALPHA LEVEL SIGNIFICANCE =	.50

CHIRA T=00004 IS ON CR00002 USING 00001 BLKS R=0005

0001	:SV,4
0002	:RP,CTAPE
0003	:RU,CHIR
0004	:OF,CTAPE
0005	:SV,0

*CHIR T=00003 IS ON CR00002 USING 00021 BLKS R=0000

```
0001 FTH4
0002 PROGRAM CHIR
0003 COMMON SC(30,70),RS(70),D(30),DR(30),RA(30,70)
0004 DIMENSION TAB(25,3),IFMT(20),ITAPE(3)
0005 DATA ITAPE/2HCT,2HAP,2HE /
0006 DATA TAB(6,1),TAB(6,2),TAB(6,3)/2.227,99.999,99.999/
0007 DATA TAB(7,1),TAB(7,2),TAB(7,3)/2.028,2.366,99.999/
0008 DATA TAB(8,1),TAB(8,2),TAB(8,3)/1.960,2.240,2.521/
0009 DATA TAB(9,1),TAB(9,2),TAB(9,3)/1.955,2.310,2.429/
0010 DATA TAB(10,1),TAB(10,2),TAB(10,3)/1.988,2.293,2.497/
0011 DATA TAB(11,1),TAB(11,2),TAB(11,3)/1.956,2.312,2.490/
0012 DATA TAB(12,1),TAB(12,2),TAB(12,3)/1.961,2.275,2.510/
0013 DATA TAB(13,1),TAB(13,2),TAB(13,3)/1.992,2.271,2.481/
0014 DATA TAB(14,1),TAB(14,2),TAB(14,3)/1.977,2.291,2.480/
0015 DATA TAB(15,1),TAB(15,2),TAB(15,3)/1.988,2.272,2.499/
0016 DATA TAB(16,1),TAB(16,2),TAB(16,3)/1.965,2.275,2.482/
0017 DATA TAB(17,1),TAB(17,2),TAB(17,3)/1.965,2.296,2.533/
0018 DATA TAB(18,1),TAB(18,2),TAB(18,3)/1.982,2.286,2.504/
0019 DATA TAB(19,1),TAB(19,2),TAB(19,3)/1.972,2.294,2.535/
0020 DATA TAB(20,1),TAB(20,2),TAB(20,3)/1.979,2.315,2.501/
0021 DATA TAB(21,1),TAB(21,2),TAB(21,3)/1.964,2.311,2.520/
0022 DATA TAB(22,1),TAB(22,2),TAB(22,3)/1.964,2.289,2.516/
0023 DATA TAB(23,1),TAB(23,2),TAB(23,3)/1.977,2.312,2.524/
0024 DATA TAB(24,1),TAB(24,2),TAB(24,3)/1.971,2.314,2.543/
0025 DATA TAB(25,1),TAB(25,2),TAB(25,3)/1.978,2.301,2.543/
0026 50 REWIND 8
0027 173 S=0
0028 CALL EXEC(9,ITAPE)
0029 REWIND 8
0030 READ(8,239) IER,ICOM
0031 IF (IER.LT.0) GO TO 333
0032 239 FORMAT(2I5)
0033 READ(8,2031) ITIES,NK,HR,IUNIT
0034 2031 FORMAT(4I5)
0035 READ(8,2033) IFMT
0036 2033 FORMAT(20A2)
0037 DO 70 I=1,70
0038 70 RS(I)=0
0039 DO 71 I=1,30
0040 DR(I)=0.
0041 71 D(I)=0
0042 SUM=0
0043 T=0
0044 DO 2 I=1,HR
0045 READ(8,IFMT) (SC(I,J),J=1,NK)
0046 2 CONTINUE
0047 DO 4 I=1,HR
0048 DO 4 J=1,NK
0049 RA(I,J)=.5
0050 DO 4 K=1,NK
```

```

0051      IF(SC(I,J).EQ.SC(I,K))RA(I,J)=RA(I,J)+.5
0052      IF(SC(I,J).GT.SC(I,K))RA(I,J)=RA(I,J)+1
0053  4      CONTINUE
0054      DO 60 I=1,NK
0055      DO 60 J=1,NR
0056  60      RS(I)=RS(I)+RA(J,I)
0057      DO 22 I=1,NK
0058  22      SUM=SUM+RS(I)
0059      SUM=SUM/NK
0060      DO 21 I=1,NK
0061  21      S=S+(RS(I)-SUM)**2
0062      IF(ITIES.EQ.0)GO TO 61
0063      DO 32 J=1,NR
0064      N=1
0065      SUM=0
0066      DO 31 I=1,NK
0067      M=1
0068      K2=I+1
0069      DO 30 K=K2,NK
0070      IF(RA(J,I).NE.RA(J,K))GO TO 30
0071      M=M+1
0072      D(N)=RA(J,I)
0073  30      CONTINUE
0074      IF(M.EQ.1)GO TO 31
0075      DO 29 K1=1,N
0076      IF(N.EQ.K1)GO TO 28
0077      IF(D(N).EQ.D(K1))GO TO 31
0078  29      CONTINUE
0079  28      SUM=SUM+(M**3-M)
0080      N=N+1
0081  31      CONTINUE
0082      IF(N.EQ.1.AND.SUM.EQ.0)GO TO 32
0083      T=T+SUM/12
0084  32      CONTINUE
0085  61      ANK=NK
0086      ANR=NR
0087      WK=S/((((ANR**2)*(ANK**3-ANK))/12)-(ANR*T))
0088      CHIK=ANR*(ANK-1)*WK
0089      NDFK=NK-1
0090      ARB=(ANR*WK-1)/(ANR-1)
0091      SBR=ANR*ARB/(1+(ANR-1)*ARB)
0092      IF(ITIES.EQ.1)GO TO 52
0093      WRITE(IUNIT,53)
0094  53      FORMAT(1H1," DATA CALCULATED WITHOUT CORRECTION FOR TIES")
0095      GO TO 51
0096  52      WRITE(IUNIT,54)
0097  54      FORMAT(1H1," DATA CALCULATED WITH CORRECTIONS FOR TIES")
0098  51      WRITE(IUNIT,9)CHIK,NDFK
0099  9      FORMAT(" CHI SQUARE FOR R= ",F8.3," DEGREES OF FREEDOM =",13)
0100      WRITE(IUNIT,10)WK
0101  10      FORMAT(" KENDALL'S W= ",F6.3)
0102      WRITE(IUNIT,11)ARB,SBR
0103  11      FORMAT(" AVERAGE ROW RELIABILITY = ",F6.3," TOTAL REL",
0104      1" IABILITY = ",F6.3,")
0105      WRITE(IUNIT,936) S

```

```

0106 936  FORMAT("      S = ",5X,F10.3,/)
0107      IF(ICOM.NE.1) STOP
0108      DO 200 I=1,30
0109 200   DR(I)=0
0110      NKR=NK-1
0111      DO 12 I=1,NKR
0112      II=I+1
0113      DO 12 J=II,NK
0114      NH=NR
0115      DO 13 K=1,NR
0116 13   D(K)=SC(K,I)-SC(K,J)
0117      NPLUS=0
0118      DO 14 K=1,NR
0119      IF(D(K).EQ.0)DR(K)=0
0120      IF(D(K).EQ.0)NH=NH-1
0121      IF(D(K).EQ.0)GO TO 14
0122      IF(D(K).GT.0)NPLUS=NPLUS+1
0123      DR(K)=.5
0124      DO 14 L=1,NR
0125      IF(D(L).EQ.0)GO TO 14
0126      IF(ABS(D(K)).EQ.ABS(D(L)))DR(K)=DR(K)+.5
0127      IF(ABS(D(K)).GT.ABS(D(L)))DR(K)=DR(K)+1
0128 14   CONTINUE
0129      MNH=(NH/2)
0130      T=0
0131      IF(NPLUS.GT.MNH)GO TO 16
0132      DO 17 K=1,NR
0133      IF(D(K).GT.0)T=T+DR(K)
0134 17   CONTINUE
0135      GO TO 19
0136 16   DO 18 K=1,NR
0137      IF(D(K).LT.0)T=T+DR(K)
0138 18   CONTINUE
0139 19   FNN=MNH
0140      TOP=FNN*(FNN+1)/4
0141      BOT=SQRT(TOP*(2*FNN+1)/6)
0142      ZEE=(T-TOP)/BOT
0143      IF(MN.LT.6)GO TO 100
0144      IF(MN.GE.6.AND.MN.LE.25)GO TO 101
0145      PR=.5
0146      IF(ZEE.GE.1.96)PR=.05
0147      IF(ZEE.GE.2.327)PR=.02
0148      IF(ZEE.GE.2.575)PR=.01
0149      GO TO 102
0150 101  PR=.5
0151      IF(ABS(ZEE).GE.TAB(MN,1))PR=.05
0152      IF(ABS(ZEE).GE.TAB(MN,2))PR=.02
0153      IF(ABS(ZEE).GE.TAB(MN,3))PR=.01
0154      GO TO 102
0155 100  PR=.5
0156 102  WRITE(IUNIT,20)I,J,ZEE,MN,PR
0157 20   FORMAT(" VAR ",I3," AND VAR ",I3,"  WILCOXIN SIGNED RANK Z =",
0158          XF8.3," # OF PAIRS = ",I3," ALPHA LEVEL SIGNIFICANCE =",F8.3,
0159          X//)
0160 12   CONTINUE
0161 333  STOP
0162      END
0163      ENDS

```

*TAPE T=00003 IS ON CR00002 USING 00009 BLKS R=000

```

0001 FTH4
0002      PROGRAM CTAPE
0003      COMMON SC(70), INAME(3), IFMT(20), IB(272), IBUF(256)
0004      WRITE(1,121)
0005 121   FORMAT("ENTER DATA FILE NAME")
0006      READ(1,98) INAME
0007 98    FORMAT(3A2)
0008      WRITE(1,194)
0009      REWIND 8
0010      READ(1,*) ITIES
0011 194   FORMAT(" DO YOU WISH TO COMPUTE WITH TIES 1=YES, 0=NO ")
0012      WRITE(1,195)
0013      READ(1,*) NK
0014 195   FORMAT(" NUMBER OF COLUMNS (MAX 70) : ")
0015      WRITE(1,196)
0016 196   FORMAT(" NUMBER OF ROWS (MAX 30) : ")
0017      READ(1,*) NR
0018      WRITE(1,198)
0019 198   FORMAT(" ENTER DATA FORMAT")
0020      READ(1,199) IFMT
0021 199   FORMAT(20A2)
0022      WRITE(1,987)
0023 987   FORMAT(" ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT")
0024      READ(1,*) IUNIT
0025      WRITE(1,45)
0026 45    FORMAT("ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0")
0027      READ(1,*) IPTO
0028      WRITE(1,393)
0029 393   FORMAT("DO YOU WANT WILKOXIN SIGN RANK Z ? , 1=YES, 0=NO")
0030      READ(1,*) ICOM
0031      WRITE(1,88)
0032 88    FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0033      READ(1,*) LENGTH
0034      LEN=LENGTH/2
0035      IF((LEN*2).NE.LENGTH) LEN=LEN+1
0036      LENGTH=LEN
0037      IDCBS=LENGTH
0038      IF(LENGTH.LT.144) IDCBS=144
0039      CALL OPEN(IB,IER,INAME,3,0,-2,IDCBS)
0040      IF(IER.GE.0) GO TO 123
0041      WRITE(1,145) INAME,IER
0042 145   FORMAT(3A2," FAILED TO OPEN , IER = ",I5)
0043      WRITE(8,20) IER,ICOM
0044 20    FORMAT(2I5)
0045      REWIND 8
0046      STOP 145
0047 123   CONTINUE
0048      WRITE(8,20) IER,ICOM
0049      WRITE(8,204) ITIES,NK,NR,IUNIT
0050 204   FORMAT(4I5)

```

```

0051      WRITE(8,205) IFMT
0052 205   FORMAT(20A2)
0053      DO 10 I=1,NR
0054      CALL READF(IB,IER,IBUF)
0055      CALL CODE
0056      READ(IBUF,IFMT) (SC(J),J=1,NK)
0057      WRITE(8,IFMT) (SC(J),J=1,NK)
0058      IF(IPTO.EQ.1) WRITE(IUNIT,209) (SC(J),J=1,NK)
0059 209   FORMAT(8F10.4)
0060      IF(IPTO.EQ.1) WRITE(IUNIT,2090)
0061 2090  FORMAT(5X)
0062 10    CONTINUE
0063      REWIND 8
0064      CALL CLOSE(IB)
0065      END
0066      END$

```

CHISQ (Chi-square)

Purpose:

This program performs a chi-squared test for independence on a row by column (R x C) contingency table and calculates the contingency coefficient.

Layout of Design:

	A ₁	A ₂		A _C	Total
B ₁	ab ₁₁	ab ₁₂		ab _{1c}	R _{1.}
B ₂	ab ₂₁	ab ₂₂		ab _{2c}	R _{2.}
.	.	.		.	.
.	.	.		.	.
.	.	.		.	.
.	.	.		.	.
B _r	ab _{r1}	ab _{r2}		ab _{rc}	R _{r.}
Total	R _{.1}	R _{.2}		R _{.c}	N

where:

R_{.i} = total in ith column
R_{j.} = total in jth row
N = overall total

Mathematical Model:

$$\chi^2 = \sum_{j=1}^R \sum_{i=1}^C \left[\frac{(O_{ij} - E_{ij})^2}{E_{ij}} \right]$$

where:

O_{ij} = observed value in i, jth position.
E_{ij} = expected value in i, jth position = R_{.i} * R_{j.}/N

The hypothesis to be tested is:

$$H_0: A_1 = A_2 = A_3 = A_c$$

User Considerations and Procedures:

1. Program expects data in a R x C matrix form. A printout of raw data would show C data points per line.
2. The data analysis can be either displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.
3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).
4. Parameters required:
 - a. number of columns (maximum 100)
 - b. number of rows (maximum 100)
 - c. data file name
 - d. format and record length of data file (see DA30)
5. Printout gives:
 - a. raw data if optioned
 - b. calculated chi-squared value with d.f. = $(R - 1) * (C - 1)$
 - c. the contingency coefficient, $C = (X^2 / (X^2 + N))^{.5}$

Comments:

Program provides calculated chi-squared value which can be compared to a critical chi-square table to determine probability.

Test Data:

This program was tested using data from S. Siegel, Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill, 1956, P. 198. Program uses double precision for accuracy.

RU,CHISO
CHI-SQUARED TEST FOR INDEPENDENCE OF A RXC
CONTINGENCY TABLE AND THE CONTINGENCY COEFFICIENT
INPUT FILE NAME

#CHISO

ENTER DATA FORMAT

(4(1X,F4.0))

NUMBER ACROSS

4

THE NUMBER DOWN:

3

ENTER THE RECORD LENGTH AS IN DA30

20

ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0

1

ENTER 1 FOR CRT OR 6 FOR LINEPRINTER OUTPUT

6

THE CONTINGENCY COEFFICIENT = .38865

:

RAJ DATA

23.	40.	16.	2.
11.	75.	107.	14.
1.	31.	60.	10.

CHI-SQAURED = 69.3893283

DEGREES OF FREEDOM = 6

*CHISQ T=00003 IS ON CR00002 USING 00010 BLKS R=0000

```
0001 FTH4
0002 PROGRAM CHISQ
0003 DOUBLE PRECISION E,X,Y,Z,CHIS,C,TOTAL
0004 DIMENSION X(100),Y(100),Z(100),NAME(3),IFMT(20)
0005 DIMENSION IB(272),IBUF(256)
0006 IUNIT=1
0007 WRITE(1,981)
0008 981 FORMAT("CHI-SQUARED TEST FOR INDEPENDENCE FO A RXC ",/,
0009 $" CONTINGENCY TABLE AND THE CONTINGENCY COEFFICIENT")
0010 WRITE(1,1111)
0011 1111 FORMAT(" INPUT FILENAME")
0012 READ(1,1)NAME
0013 1 FORMAT(3A2)
0014 WRITE(1,1112)
0015 1112 FORMAT(" ENTER DATA FORMAT")
0016 READ(1,54)IFMT
0017 54 FORMAT(20A2)
0018 WRITE(1,1113)
0019 1113 FORMAT ("NUMBER ACROSS")
0020 READ(1,*) NC
0021 WRITE(1,114)
0022 READ(1,*) NR
0023 114 FORMAT ("THE NUMBER DOWN : ")
0024 TOTAL=0.
0025 CHIS=0.
0026 IDCBS=256
0027 CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
0028 IF(IER.GE.0) GO TO 123
0029 WRITE(1,124) NAME,IER
0030 124 FORMAT(3A2," FAILED TO OPEN , IER = ",I5)
0031 STOP 123
0032 123 CONTINUE
0033 WRITE(1,459)
0034 459 FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0")
0035 READ(1,*) IPTO
0036 WRITE(1,56)
0037 56 FORMAT("ENTER 1 FOR CRT OR 6 FOR LINPRINTER OUTPUT")
0038 READ(1,*) IUNIT
0039 IF(IPTO.NE.1) GO TO 987
0040 WRITE(IUNIT,3679)
0041 3679 FORMAT(/,"RAW DATA",/)
0042 987 WRITE(IUNIT,913)
0043 913 FORMAT(///)
0044 DO 100 J=1,NR
0045 CALL READF(IB,IER,IBUF)
0046 CALL CODE
0047 READ(IBUF,IFMT) (X(I),I=1,NC)
0048 IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (X(I),I=1,NC)
0049 DO 100 I=1,NC
0050 Y(I)=Y(I)+X(I)
```

```

0051      Z(J)=Z(J)+X(I)
0052 100    CONTINUE
0053      DO 101 J=1,NC
0054 101    TOTAL=TOTAL+Y(J)
0055      CALL RWNDF(IB)
0056      DO 200 J=1,NR
0057      CALL READF(IB,IER,IBUF)
0058      CALL CODE
0059      READ(IBUF,IFMT)(X(I),I=1,NC)
0060      DO 200 I=1,NC
0061      E=Y(I)*Z(J)/TOTAL
0062 200    CHIS=CHIS+(X(I)-E)*(X(I)-E)/E
0063      N=(NC-1)*(NR-1)
0064      C=DSQRT(CHIS/(CHIS+TOTAL))
0065      WRITE(IUNIT,9876) CHIS,N
0066 9876    FORMAT(//,5X,"CHI-SQUARED =",F14.7,10X,"DEGREES OF FREEDOM =",
0067           C,I5)
0068      WRITE(IUNIT,1115) C
0069 1115    FORMAT(//," THE CONTINGENCY COEFFICIENT = ",F10.5)
0070      CALL CLOSE(IB)
0071      END
0072      END$

```

APPENDIX A
GENERALIZED SUBROUTINES

APPENDIX A
GENERALIZED SUBROUTINES

FPROB and YNORM are subroutines used in many of the statistical programs. FPROB calculates the probability value for the F-statistic in the analyses of variance and covariance programs. There are five arguments for FPROB (F, DF1, DF2, Z, and P). The three parameters passed to the subroutine are the F-statistic value and the two degrees of freedoms associated with the F. The return parameters are the Z-value and the probability calculation, P. YNORM is used to normalize scores. There are two arguments for YNORM (DZ, YORMX). DZ is the initial score value which is passed to the subroutine; YORMX is the recalculated score that is returned to the original program. Program listings for these two subroutines are on the following pages.

*FPROD T=00003 IS ON CR00002 USING 00004 BLKS R=0000

```
0001  FTH4,L
0002      SUBROUTINE FPROD(F,DF1,DF2,Z,P)
0003      DOUBLE PRECISION EDF1,EDF2,FA,T,A,B,TOP,BOT,CA,CB,CC,CD
0004      DOUBLE PRECISION F,DF1,DF2,Z,P
0005      P=1.0
0006      EDF1=DF1
0007      EDF2=DF2
0008      FA=F
0009      IF(F.LE.0.)GO TO 100
0010      IF(EDF1.LE.0.)GO TO 100
0011      IF(EDF2.LE.0.)GO TO 100
0012      IF(F.GE.1.0)GO TO 60
0013      FA=1.0/F
0014      T=EDF1
0015      EDF1=EDF2
0016      EDF2=T
0017  60      A=2./(9.*EDF1)
0018          B=2./(9.*EDF2)
0019          TOP=(1.-B)*FA**(.1/3.)-1.+A
0020          BOT=DSQRT(B*FA**(.2/3.)+A)
0021          Z=DABS(TOP/BOT)
0022          IF(EDF2.GT.3.)GO TO 80
0023          Z=Z*(1+.08*Z**4/EDF2**3)
0024  80      CA=.196854
0025          CB=.115194
0026          CC=.000344
0027          CD=.019527
0028          T=Z*(CA+Z*(CB+Z*(CC+Z*CD)))
0029          T=(1.+T)**4
0030          P=.5/T
0031          IF(F.GE.1.0)GO TO 100
0032          P=1.-P
0033  100      RETURN
0034          END
0035          END$
```


*YNGRN T=00003 IS ON CR00C02 USING 00006 BLKS R=0000

```

0001  FTH4
0002      SUBROUTINE YNGRN(DZ,YORMX)
0003      DOUBLE PRECISION DZ,DPI,YORMX,DX,DAL,DBL,DAH,DBH,DAH,DBI,DAI,
0004      DFA,DFB,DAC,DBC
0005      DPI=.398942280401433
0006      DX=DABS(DZ)
0007      YORMX=0.000
0008      IF(DZ.LT.-18.70) GO TO 99
0009      YORMX=1.00
0010      IF(DZ.GT.9.00) GO TO 99
0011      IF(DX.GT.3.00) GO TO 10
0012      DAL=0.000
0013      DBL=1.000
0014      DAH=DX
0015      DBH=1.00
0016      DAI=0.000
0017  5      DAH=DAH+1.000
0018      DBI=-(2.00*DAH-1.00)*DX*DX
0019      DBI=4.00*DAH-1.00
0020      DAL=DBI*DAH+DAI*DAL
0021      DBL=DBI*DBH+DAI*DBL
0022      DAI=DX*DX-DAI
0023      DBI=2.00+DBI
0024      DAH=DBI*DAL+DAI*DAH
0025      DBH=DBI*DBL+DAI*DBH
0026      DFA=DAL/DBL
0027      DFB=DAH/DBH
0028      IF(DFB.EQ.0.00) GO TO 20
0029      IF(DABS((DFB-DFA)/DFA).LE.1.0-10) GO TO 20
0030      GO TO 5
0031  10      DAL=0.000
0032      DBL=1.000
0033      DAH=1.000
0034      DBH=DX
0035      DBI=DX
0036      DAI=1.00
0037      DFA=1.00/DX
0038  15      DAH=DAH+1.000
0039      DAI=DAH-1.00
0040      DAC=DBI*DAH+DAI*DAL
0041      DBC=DBI*DBH+DAI*DBL
0042      DFA=DAC/DBC
0043      DAL=DAH
0044      DBL=DBH
0045      DAH=DAC
0046      DBH=DBC
0047      IF(DFB.EQ.0.00) GO TO 20
0048      IF(DABS((DFB-DFA)/DFB).LE.1.0-10) GO TO 20
0049      DFA=DFB
0050      GO TO 15
0051  20      YORMX=DPI*DFB*DEXP(-DX*DX/2.00)
0052      IF(DX.LE.3.00) YORMX=0.500-YORMX
0053      IF(DZ.GT.0.00) YORMX=1.000-YORMX
0054  99      RETURN
0055      END
0056      END*

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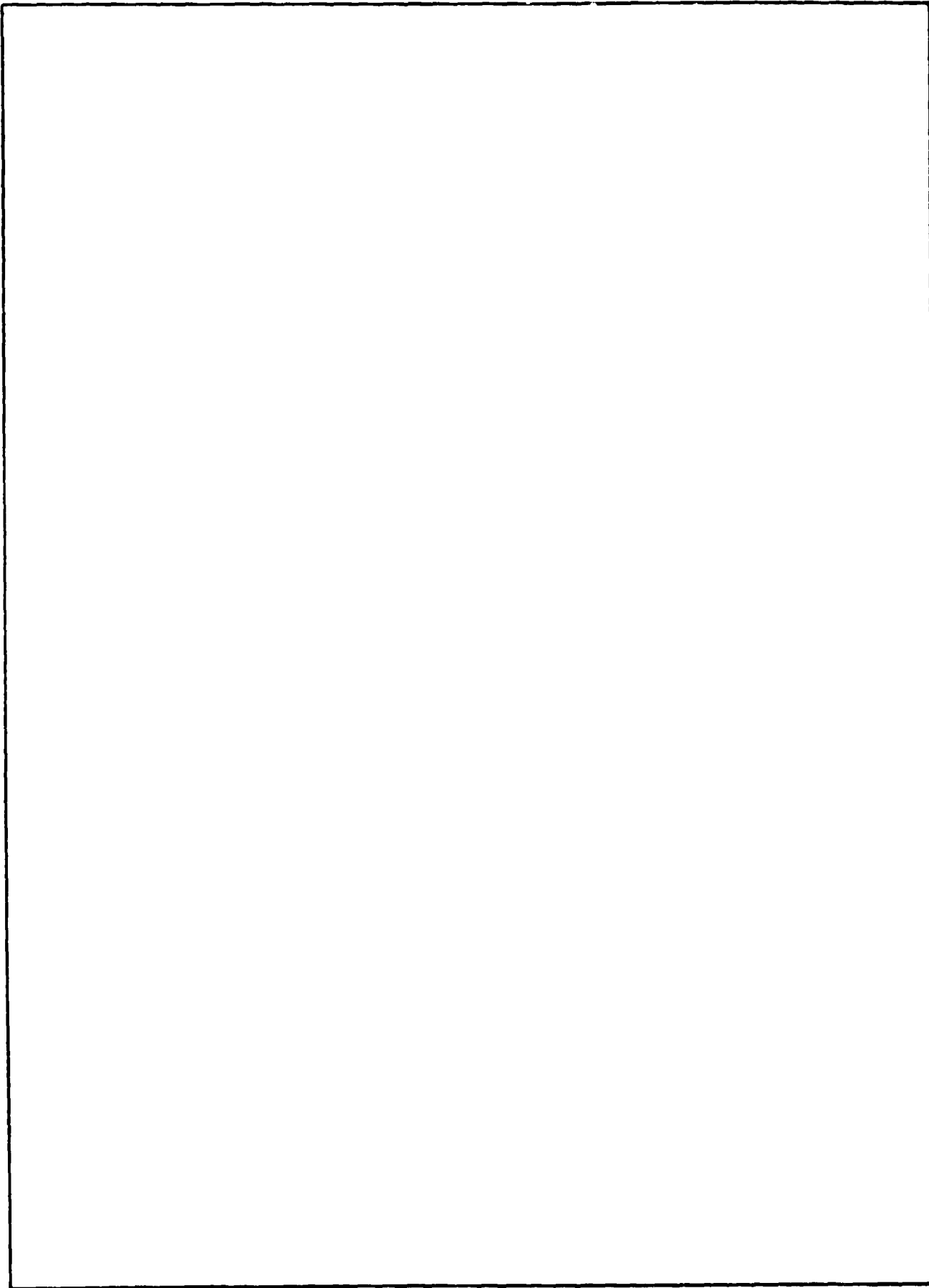
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